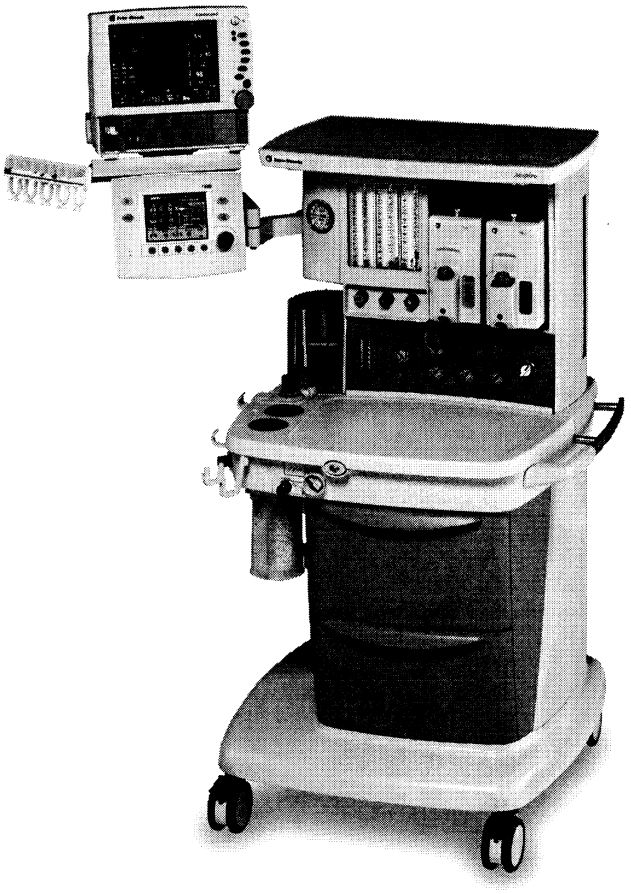
GE Healthcare

Aespire 7100 Anesthesia Machine
Technical Reference Manual



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AAA**X**11111	AAA**XX**111111AA
The **X** represents an alpha character indicating the year the product was manufactured; **H** = 2004, **J** = 2005, etc. **I** and **O** are not used.	The **XX** represents a number indicating the year the product was manufactured; **04** = 2004, **05** = 2005, etc.

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08/07 M1110140

Covers the following:

Aespire 7100 anesthesia machine (with non-color or color display)

Aespire 100 anesthesia machine

S/5 ProTIVA anesthesia machine

Software Revisions 1.X and 2.X

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Important

The information contained in this Technical Reference manual pertains only to those models of products which are marketed by Datex-Ohmeda as of the effective date of this manual or the latest revision thereof. This Technical Reference manual was prepared for exclusive use by Datex-Ohmeda service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, Datex-Ohmeda provides this Technical Reference manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from Datex-Ohmeda does not imply in anyway that Datex-Ohmeda deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Technical Communications, Datex-Ohmeda, Ohmeda Drive, PO Box 7550, Madison, Wisconsin 53707.

⚠ CAUTION Servicing of this product in accordance with this Technical Reference manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.

Technical Competence

The procedures described in this Technical Reference manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

Datex-Ohmeda strongly recommends using only genuine replacement parts, manufactured or sold by Datex-Ohmeda for all repair parts replacements.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

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1 Introduction

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1.1 What this manual includes

Anesthesia Machine

This manual covers the service information for the Aespire 7100 line of anesthesia machines. It covers the following components:

- 7100 display components: color and non-color
- Vent Engine components
- gas delivery components,
- breathing system components,
- frame component (except those strictly associated with a specific ventilator),
- optional suction regulator and auxiliary O_2 flowmeter.

S/5 ProTIVA

The ProTIVA machine is configured with standard Aespire machine components, with the exception of the vaporizer manifold and the Ventilator/ Monitoring Display (7100 Control Module) mounting solution (refer to Section 10.5).

B Braun equipment is not covered in this manual. Refer to B Braun service documentation.

Other equipment

Other equipment may be attached to the system on the display mount, the top shelf, or on the side dovetail rails. Consult separate documentation relative to these items for details.

1.2 Standard service procedures

1.2.1 User's Reference Manuals

Some sections of this manual refer you to the User's Reference Manual for the Aespire machine. To expedite repairs, you must have, and be familiar with, the User's Reference Manuals for this product.

Refer to the Aespire User's Reference Manual if you need further information about the operation of the system.

1.2.2 Software versions

The revision level is displayed on the ventilator start-up menu. This manual includes test and calibration procedures for Revision 1.X and 2.X software.

1.2.3 Ventilator tests

Service calibration functions let Datex-Ohmeda trained users and Datex-Ohmeda service personnel perform ventilator setup functions, tests, calibration and measurements from the front panel display.

Normal operational tests, calibration, and troubleshooting can be performed on your 7100 ventilator without removing components from the system. Repair may require removing the ventilator components from the anesthesia machine.

⚠ WARNING Section 4, *"Service Mode Tests and Calibration"* must be performed whenever you access any internal component of the ventilator to verify that all critical parts of the ventilator are still operational and within specification.

⚠ WARNING After the ventilator has been serviced, you must perform *"Post-Service Checkout"* to verify the entire anesthesia system is properly functioning before the system can be returned to clinical use.

1.3 Overview

The Aespire 7100 machine is a compact, integrated and intuitive anesthesia delivery system. The ventilator portion provides mechanical ventilation to a patient during surgery as well as monitoring and displaying various patient parameters.

The system uses a microprocessor-controlled ventilator with internal monitors, electronic PEEP, Volume Mode, and other optional features. A serial interface permits communication to cardiovascular and respiratory gas monitoring.

Note Configurations available for this product depend on local market and standards requirements. Illustrations in this manual may not represent all configurations of the product.

The Aespire machine is not suitable for use in an MRI environment.

1.3.1 Aespire 100

The Aespire 100 machine is based on the standard Aespire 7100 machine with the following exceptions to available features or options:

- does not include the RS232 Serial Interface
- does not include the Bi-level LED light strip
- the 2 Vap manifold is standard (does not support 1 Vap manifold)
- not available with AC power outlets (area used by AC Inlet)
- uses 4-inch casters instead of 5-inch casters

1.3.2 S/5 ProTIVA

The S/5 ProTIVA is a special adaptation of the Aespire 7100 machine (does not include vaporizer manifold) for use with B Braun intravenous drug delivery components.

1.4 Configuration options

1.4.1 Standard configuration

The standard configuration includes the following items.
Items marked with an asterisk (*) are not included in the Aespire 100 machine.

- 7100 Ventilator (with color or non-color display)
- Advanced Breathing System (ABS)
- Auxiliary Common Gas Outlet (ACGO)
- Serial Interface - RS232*
- Bi-level LED light strip*
- Two large drawers

1.4.2 Options

Options include the following items.
Items marked with an asterisk (*) are not available in the Aespire 100 machine).

- selected software features
- vaporizer manifold (1 Vap* or 2 Vap)
- pipeline configurations (O_2/N_2O, O_2/Air, or O_2/N_2O/Air)
- gas cylinder configurations (two inboard, one outboard)
  - inboard configuration = O_2/N_2O, O_2/Air, or O_2/O_2
  - outboard configuration = N_2O only
- manual bag (on support arm or on tube)
- EZchange Canister (CO_2 Bypass) and Condenser
- gas scavenging (active, adjustable, passive, or venturi)
- a suction regulator (pipeline vacuum or venturi vacuum)
- an auxiliary O_2 flowmeter
- localized electrical power outlets* (isolated or non-isolated)
- various display mounting solutions

1.5 Components

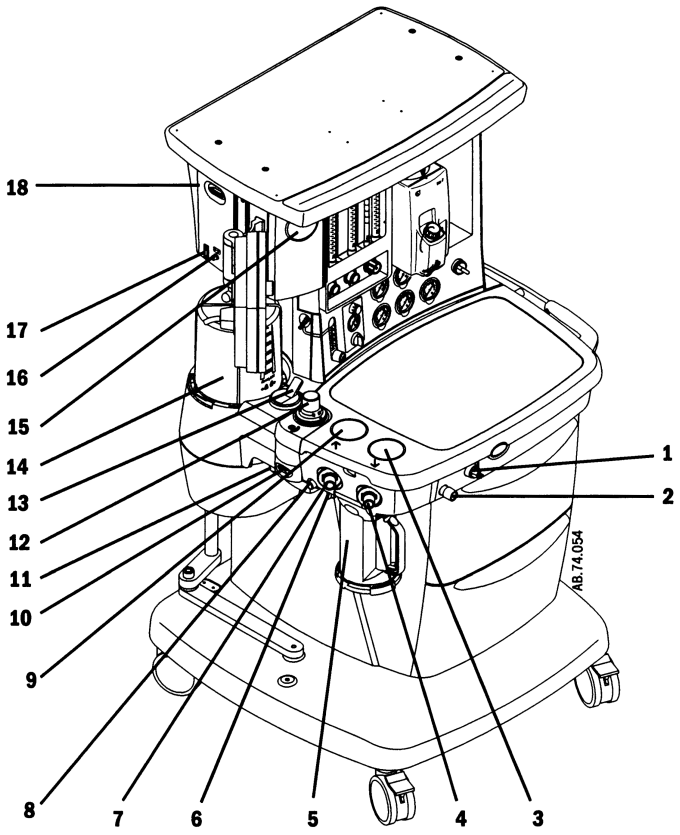
The following figures show the front and rear views of the machine.
There are some differences between models.

Figure 1-1 • Aespire machine (front view - left side)

Figure 1-2 • Aespire machine (front view - right side)

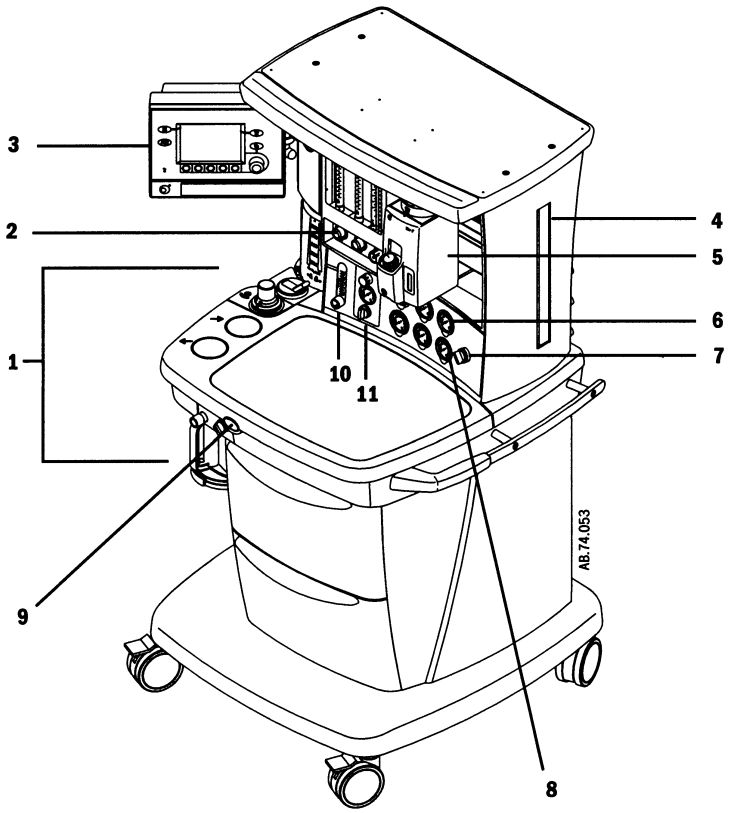
Figure 1-3 • Aespire machine (rear view)

Figure 1-4 • S/5 ProTIVA with a typical B Braun fluid manager (fm) system



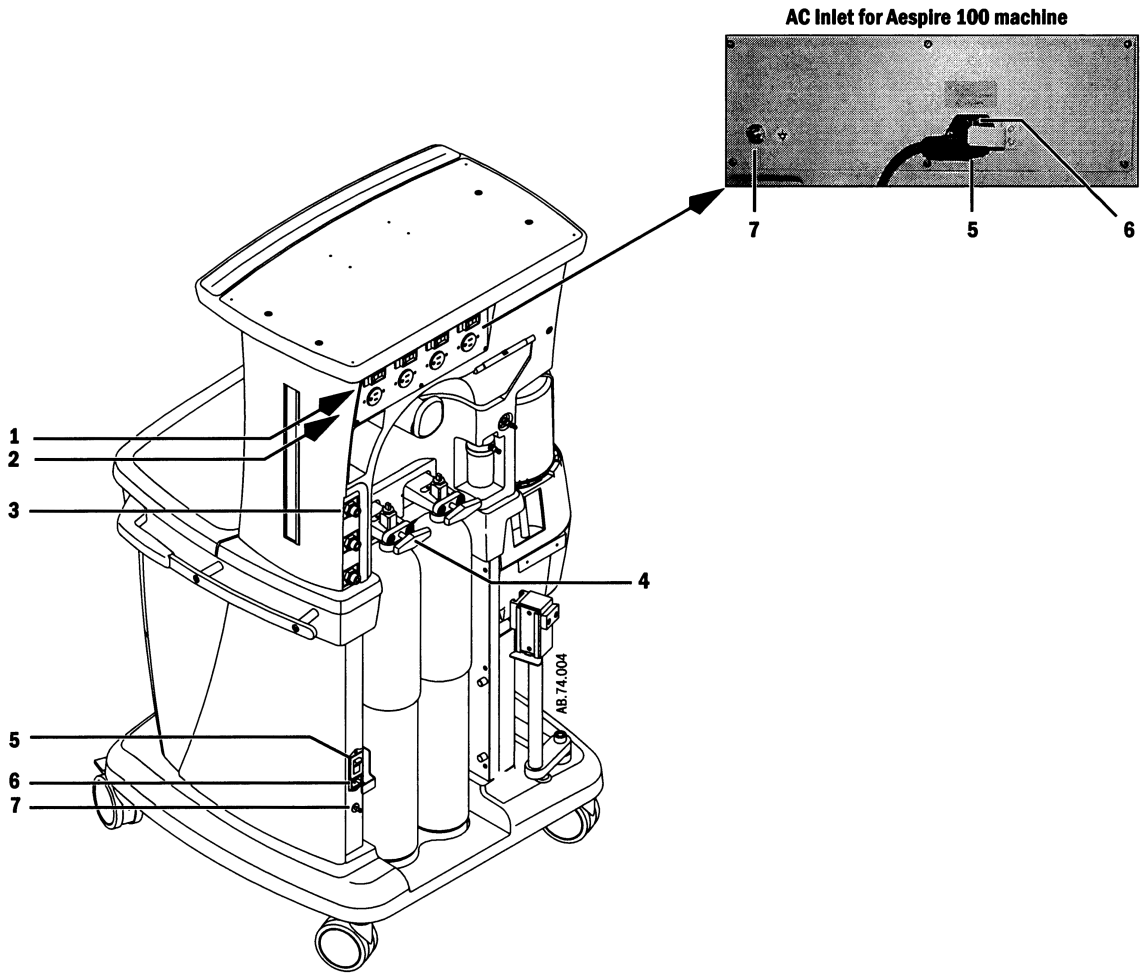
1. **Auxiliary common gas outlet (ACGO) switch**
2. **ACGO**
3. **Inspiratory check valve**
4. **Inspiratory flow sensor or flow port adapter**
5. **Canister (carbon dioxide absorbent)**
6. **Canister release**
7. **Expiratory flow sensor or flow port adapter**
8. **Leak test plug**
9. **Expiratory check valve**
10. **Breathing system release**
11. **Manual bag port**
12. **APL (adjustable pressure-limiting) valve**
13. **Bag/Vent switch**
14. **Bellows assembly**
15. **Pressure gauge (airway)**
16. **Sample gas return port**
17. **Scavenging flow indicator**
18. **RS-232 Serial port (not available in the Aespire 100 machine)**

Figure 1-1 • Aespire machine (front view - left side)



1. **ABS (Advanced Breathing System)**
2. **Flow controls**
3. **Ventilator Display/Control Module (color or non-color)**
4. **Dovetail rails**
5. **Vaporizer**
6. **Pipeline pressure gauge(s) (upper row)**
7. **System switch**
8. **Cylinder pressure gauge(s) (lower row)**
9. **O_2 Flush**
10. **Auxiliary O_2 flowmeter**
11. **Suction regulator**

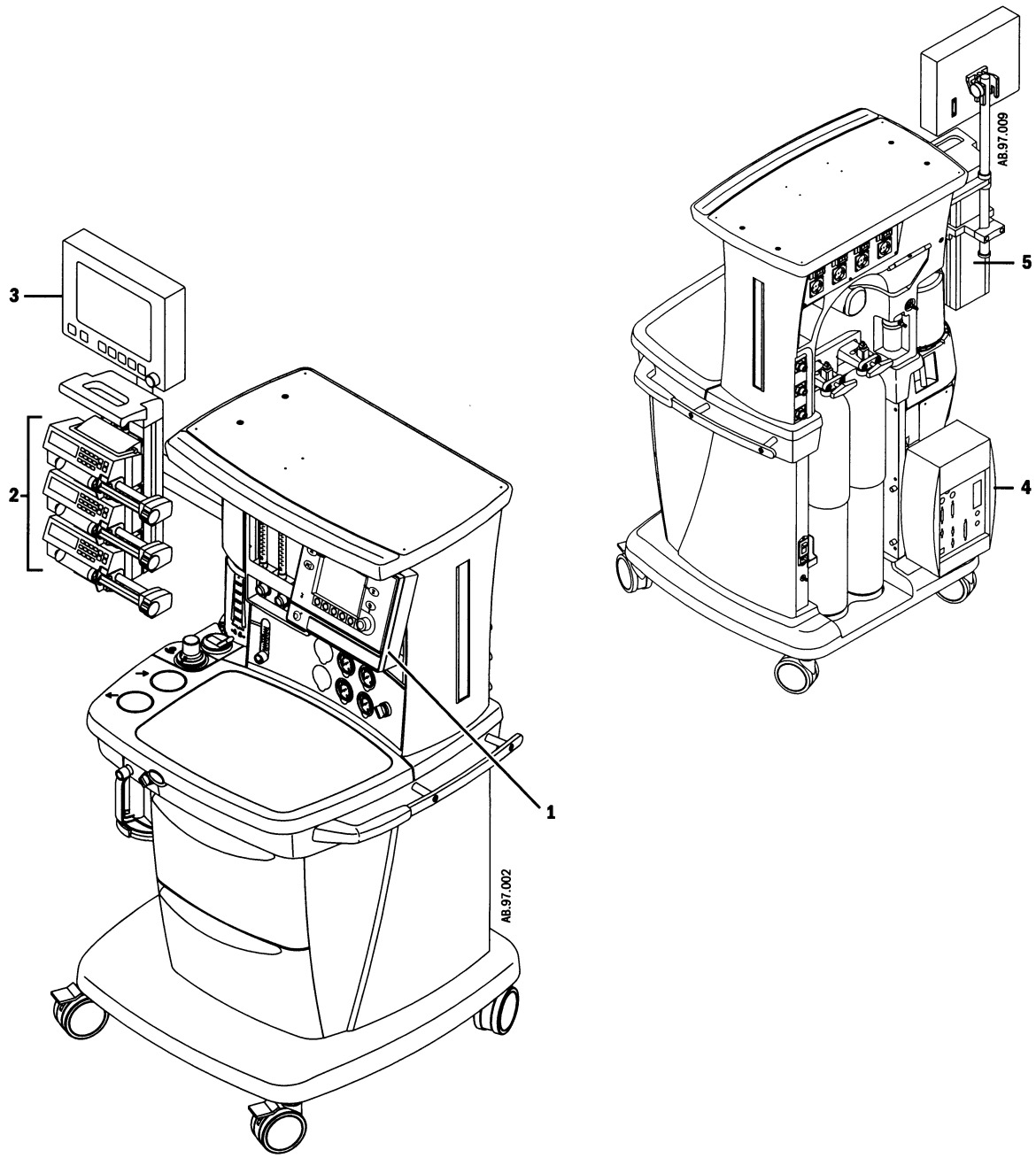
Figure 1-2 • Aespire machine (front view - right side)



1. **Circuit Breaker for Electrical Outlets***
2. **Electrical Outlets***
3. **Pipeline Connection(s)**
4. **Cylinder Supplies**
5. **System Circuit Breaker (AC Inlet fuses for Aespire 100 machine)**
6. **Mains Inlet**
7. **Equipotential Stud**

* Items marked with an asterisk (*) are not available in the Aespire 100 machine.

Figure 1-3 • Aespire machine (rear view)



1. **Ventilator/Monitoring display**
2. **Syringe pumps (3)**
3. **fm controller**
4. **fm computer**
5. **fm segment**

Figure 1-4 • S/5 ProTIVA with a typical B Braun fluid manager (fm) system

1.6 Symbols used in the manual or on the equipment

Symbols replace words on the equipment, on the display, or in Datex-Ohmeda manuals. No one device or manual uses all of the symbols.

Warnings and Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual:

- Warnings tell about a condition that can cause injury to the operator or the patient.
- Cautions tell about a condition that can cause damage to the equipment.

Read and follow all warnings and cautions.

On (power)

Off (power)

Standby

Standby or preparatory state for part of the equipment

"ON" only for part of the equipment

"OFF" only for part of the equipment

Direct current

Alternating current

Protective earth ground

Earth ground

Frame or chassis ground

Equipotential

Alarm silence

Alarm silence

Type B equipment

Type BF equipment

Type CF equipment

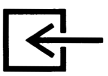
Caution, ISO 7000-0434

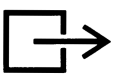
Attention, refer to product instructions, IEC 60601-1

Dangerous voltage

Electrical input

Electrical output


Pneumatic input


Pneumatic output

+	Plus, positive polarity
-	Minus, negative polarity
	Variability
	Variability in steps
	Lamp, lighting, illumination
	This way up
	Pipeline
	Lock
	Unlock
	Close drain
	Drain (remove condensate)
	Not autoclavable
134°C	Autoclavable
⚠≈ cmH2O	APL settings are approximate

	Movement in one direction
	Movement in two directions
	Read top of float
	Read to center of float
	Vacuum inlet
	Suction bottle outlet
	Cylinder
	Isolation transformer
	Linkage system
	Risk of Explosion.
	Low pressure leak test
	Mechanical ventilation
	Bag position/ manual ventilation
O_2+	O_2 Flush button

Inspiratory flow

Inspiratory flow

Pinch hazard

Circle breathing circuit module

The primary regulator is set to pressure less than 345 kPa (50 psi)

Absorber on

Absorber off (CO_2 Bypass active)

No battery/battery failure

REF

Stock Number

SN

Serial Number

Authorized representative in the European Community

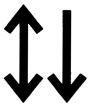
Date of Manufactur

Manufacturer

Expiratory flow

Expiratory flow

Submenu

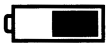


Bain/Mapleson D breathing circuit module

The primary regulator is set to pressure less than 414 kPa (60 psi)

CO_2 Bypass Option

EZchange Canister (CO_2 bypass)



Battery in use. Bar indicates amount of battery power remaining.

MAX

Maximum

℞ ONLY

Caution: federal law prohibits dispensing without prescription.

CE
xxxx

Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their User's Reference manuals. The xxxx is the certification number of the Notified Body used by Datex-Ohmeda's Quality Systems.

GOST R Russian certification

2 Theory of Operation

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2.1 Theory overview

This section describes:

- The flow of gas through the anesthesia machine.
- The flow of gas through the breathing system.
- Electrical signals between the anesthesia machine, including the breathing system, and the ventilator.
- Ventilator mechanical subsystems

2.2 Gas flow through the anesthesia machine

2.2.1 Overview

Refer to Figure 2-1.

Gas supplies

Gas comes into the system through a pipeline (**2**) or cylinder (**4**) connection. All connections have indexed fittings, filters, and check valves (one-way valves). Gauges show the pipeline (**1**) and cylinder (**3**) pressures.

A primary regulator (**5**) decreases the cylinder pressures to approximately pipeline levels. A pressure relief valve (**6**) helps protect the system from high pressures.

To help prevent problems with the gas supplies:

- Install yoke plugs on all empty cylinder connections.
- When a pipeline supply is adequate, keep the cylinder valve closed.

O_2 flow

Pipeline or regulated cylinder pressure supplies O_2 directly to the ventilator (**7a** for O_2 drive gas) and the venturi suction (**21a** for O_2 drive gas) supply connection. An additional regulator (**13**) decreases the pressure for the flush valve (**14a**) and the auxiliary flowmeter (**25**).

The flush valve supplies high flows of O_2 to the fresh gas outlet (**26** or **27**) when you push the flush button. The flush pressure switch (**14b**) monitors activation of the flush valve.

When the system switch (**8**) is On, O_2 flows to the rest of the system.

A secondary regulator (**10**) supplies a constant O_2 pressure to the O_2 flow control valve (**11**). There is a minimum flow of 25 to 75 mL/min (for dual-tube flowmeters) or 175 to 225 mL/min (for single-tube flowmeters) through the O_2 flowmeter (**12**).

The O_2 pressure switch (**9**) monitors the O_2 supply pressure. If the pressure is too low, an alarm appears on the ventilator display.

Air and N_2O flow

Pipeline or regulated cylinder pressure supplies Air directly to the ventilator (**7b** for Air drive gas) and the venturi suction (**21b** for Air drive gas) supply connection.

Note: Original production machines include a secondary regulator (**18**) at the input to the Air flow control valve (**19**).

When the system switch (**8**) is On, air flows to the Air flow control valve (**19**). Because there is no balance regulator, air flow continues at the set rate during an O_2 supply failure.

A balance regulator (**15**) controls the N_2O supply pressure to the N_2O flow control valve(**16**). The O_2 secondary regulator pressure at a pilot port controls the output of the balance regulator. The N_2O output pressure drops with decreasing O_2 supply pressure and shuts off hypoxic gas flow before the O_2 supply pressure reaches zero.

A chain link system (Link-25) on the N_2O and O_2 flow controls (**16, 11**) helps keep the O_2 concentration higher than 21% (approximate value) at the common gas outlet.

Mixed gas

The mixed gas goes from the flowmeter outlet, through the vaporizer manifold and vaporizer (**23**) that is On, to the ACGO selector switch (**E**). A pressure relief valve (**24**) limits the maximum outlet pressure.

The ACGO selector switch directs the mixed gas to the selected circuit – to the breathing system (**26**) or to the ACGO (**27**).

Key to Numbered Components

1. Pipeline pressure gauge
2. Pipeline inlet
3. Cylinder pressure gauge
4. Cylinder inlet (maximum of 3 cylinders)
5. Primary regulator (cylinder pressure)
6. High-pressure relief valve (758 kPa / 110 psi)*
7. Supply connections for the ventilator
   a. O_2 drive gas
   b. Air drive gas
8. System switch
9. Switch for low O_2 supply pressure alarm (used with the ventilator)
10. O_2 secondary regulator (207 kPa / 30 psi)*
11. O_2 flow control valve
12. O_2 flow tube(s)
13. O_2 flush and auxiliary flowmeter regulator (241 kPa / 35 psi)*
14. O_2 Flush
    a. Flush valve
    b. Pressure switch (used with the ventilator)
15. N_2O balance regulator
16. N_2O flow control valve
17. N_2O flow tube(s)
18. Air secondary regulator (207 kPa / 30 psi)*
19. Air flow control valve
20. Air flow tube(s)
21. Supply connection for Venturi suction
    a. O_2 drive gas
    b. Air drive gas
22. Vaporizer port valve
23. Vaporizer
24. Low-pressure relief valve (38 kPa / 5.5 psi)*
25. Auxiliary flowmeter (optional)
26. To ABS
27. To ACGO
28. Test port (primary regulator)
29. Test port (secondary/balance regulator)

* Approximate values

Note: Current production machines do not include a secondary regulator (**18**) in the Air flowhead module.

Key to Symbols

Pneumatic Connection

Filter

Direction of Flow

Check Valve

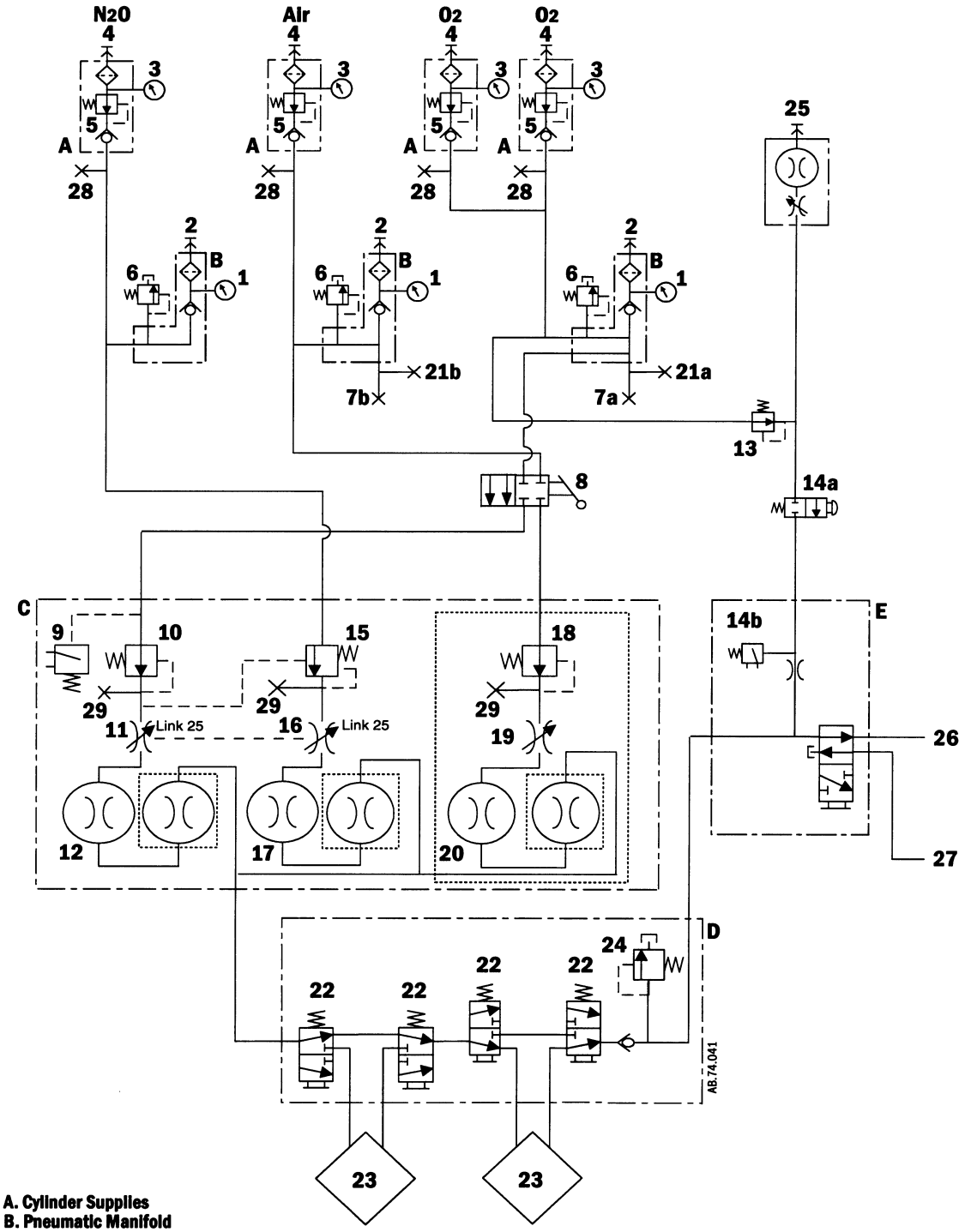


Figure 2-1 • Pneumatic circuit

2.2.2 Physical connections

Figure 2-2 shows the physical path that the gas takes.

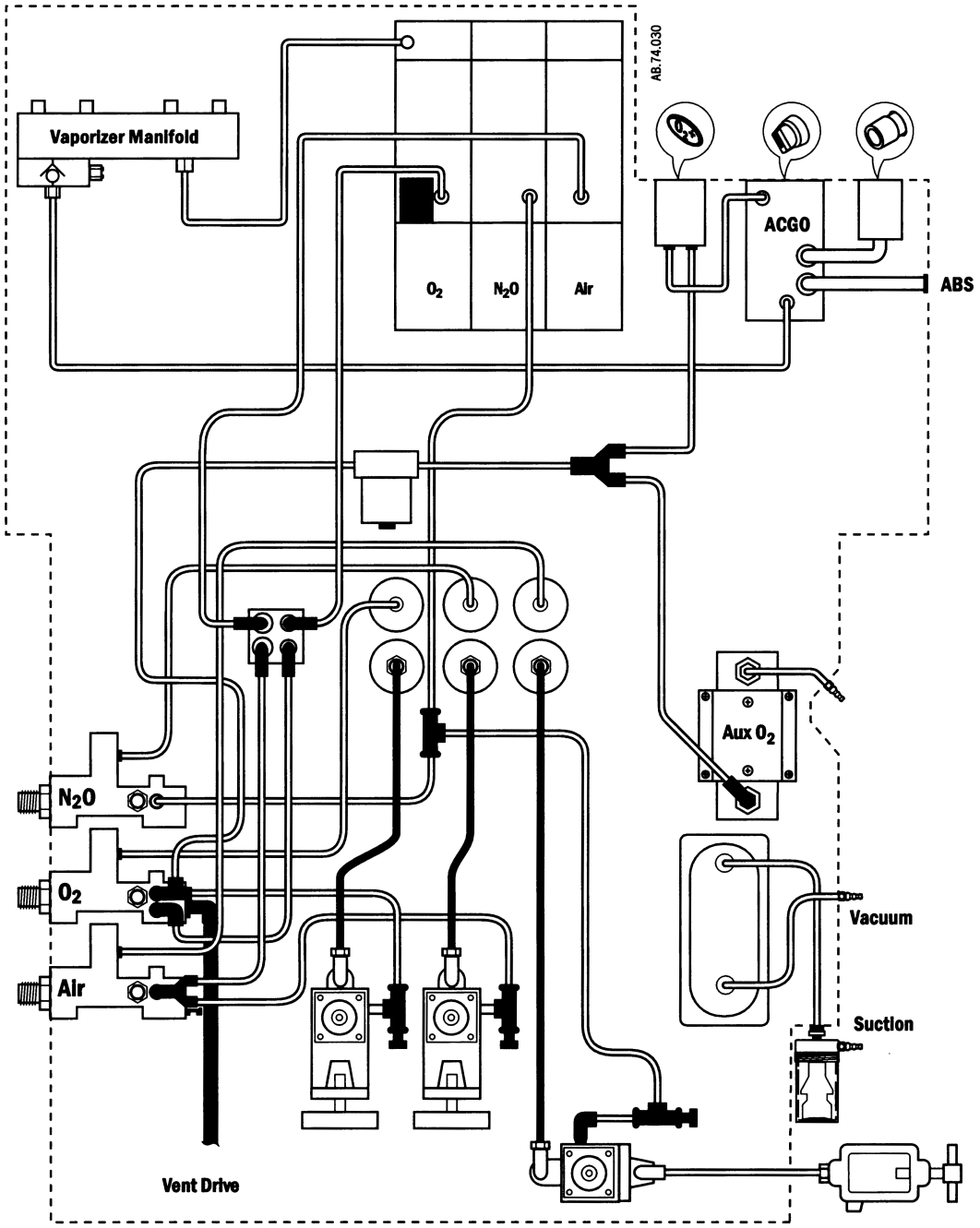


Figure 2-2 • Typical tubing connections - pictorial

2.2.3 Suction regulators

Pipeline vacuum

The suction regulator (shown in Figure 2-2) uses an external vacuum source.

Venturi Drive vacuum

The suction regulator (shown in Figure 2-3) uses an internal, venturi derived vacuum source.

Drive gas (internally plumbed **Air** or O_2) enters the Venturi Module (**VM**) at the drive port (**A**). As the drive gas passes through the venturi module, a vacuum is created at port **B**. The drive gas exits the venturi module at port **C** and is exhausted outside the machine through the muffler (**D**).

The control port (**E**) on the venturi module responds to pneumatic signals from the front panel switch on the Suction Control Module (**SCM**) to turn the venturi vacuum drive gas on or off. The check valve (**CV**) helps prevent pressurization of the suction circuitry if the exhaust is occluded or the venturi unit fails.

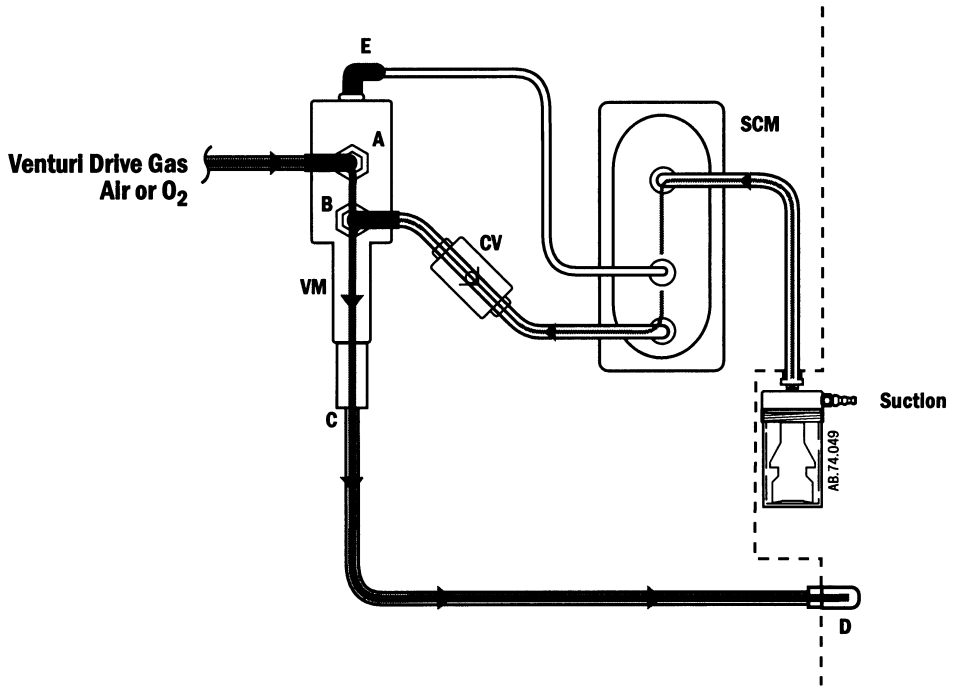


Figure 2-3 • Venturi suction

2.2.4 System switch

The system switch has two positions: On and Standby.

In the Standby position

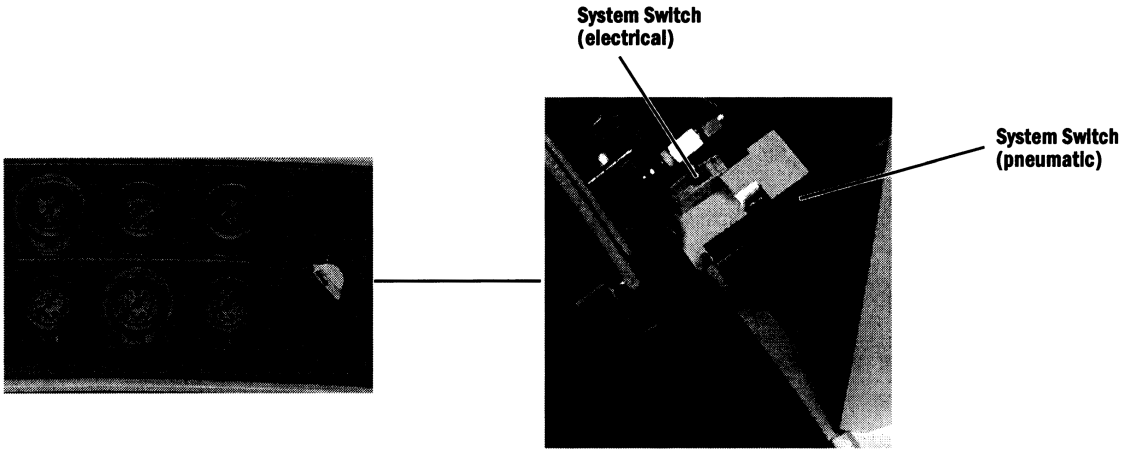
The switch:

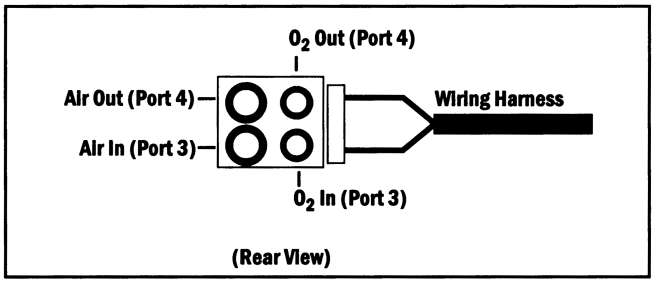
- Turns off the ventilator (electrical).
- Stops O_2 and Air to the flowhead (pneumatic).
- Without O_2 pressure, the N_2O balance regulator stops N_2O.

In the On position

The switch:

- Turns on the ventilator (electrical).
- Supplies O_2 and Air to the flowhead.
- With adequate O_2 pressure, the N_2O balance regulator supplies N_2O.



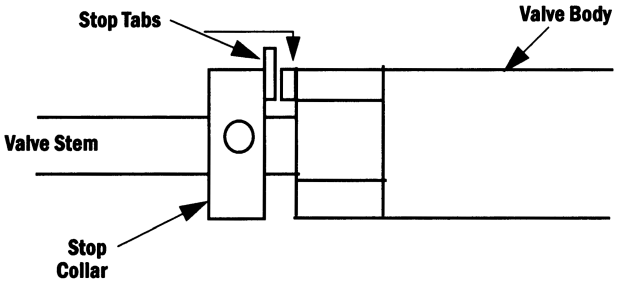


2.2.5 Flow control

Needle valves (one for each gas) adjust gas flows. Clockwise rotation decreases flow. Counterclockwise increases flow. Mechanical stops set minimum flows for all gases. The link system sets the maximum ratio of N_2O to O_2.

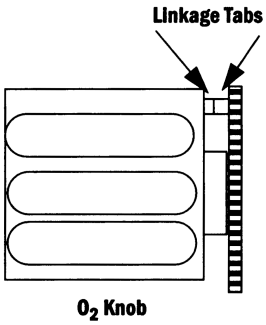
⚠ WARNING The Link 25 Proportioning System sets a minimum O_2 concentration in the fresh gas stream when only O_2 and N_2O are used. Use of an absorber or another gas can still cause a hypoxic mixture to be delivered to the patient, especially at low O_2 flow rates.

Minimum flows At minimum flow, two tabs prevent clockwise rotation of the valve stem. One tab is on the stop collar; the other is on the valve body.



Link system The chain link system helps assure an approximate minimum 1 to 3 ratio of flow between O_2 and N_2O. When engaged (minimum O_2 concentration), a tab on the O_2 knob is in contact with a tab on the O_2 sprocket so that the O_2 and N_2O knobs turn together:

- an increase in N_2O flow causes an increase in O_2 flow,
- a decrease in O_2 flow causes a decrease in N_2O flow.



Higher concentrations of O_2 are possible when the link system is not engaged: either by reducing the N_2O flow below the point of engagement or by increasing O_2 flow above the point of engagement.

When the N_2O flow is below the point of engagement, increasing the N_2O flow turns the O_2 sprocket without changing the O_2 flow. At the point of engagement, the tab on the O_2 sprocket makes contact with the tab on the O_2 knob. Once the linkage is engaged, turning the N_2O flow control counterclockwise (increase in N_2O flow) also turns the O_2 knob counterclockwise (increase in O_2 flow) to maintain a nominal 25% minimum O_2 concentration.

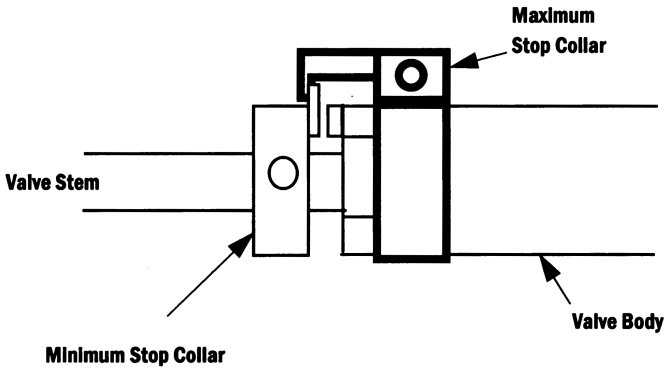
Decreasing the N_2O flow from the engagement point rotates the tab on the O_2 sprocket away from the tab on the O_2 knob. Increasing the O_2 flow rotates the knob tab away from the sprocket tab. Either action increases the O_2 concentration above 21%. Sufficiently decreasing O_2 flow or increasing the N_2O flow brings the two tabs back into contact and engages the linkage.

The kick-in point is defined as the N_2O flow at which the N_2O valve becomes engaged with the O_2 valve flowing at 200 mL/min. This engagement point is an arbitrary benchmark that assists in calibrating the proportioning system. The position of the kick-in is set in the factory. During field calibration, you set the O_2 flow to 200 mL/min and the N_2O flow to the kick-in flow (usually in the range of 400 to 700 mL/min) and then install the sprockets with the O_2 knob/sprocket engaged.

Maximum flows

When the Aespire machine was first produced, all gas flows in Canada required maximum flow stops. Early production Aespire machines shipped to Canada include a maximum stop collar on the body of the needle valve to set the maximum flow.

Canada no longer requires maximum flow stops for the gasses that the Aespire machine is designed to deliver. Current production Aespire machines do not include the maximum stop collar.



2.3 Flow through the breathing system

2.3.1 Overview of flow paths

This section looks at four types of flow paths.

- **Ventilation paths:** How gas flows from the drive source (bag or bellows) to and from the patient.
- **Fresh gas paths:** Fresh gas can flow from the machine interface directly to the patient through the inspiratory check valve, or through the absorber into the expiratory flow, or directly to an external circuit through the optional auxiliary common gas outlet.
- **Scavenged gas paths:** APL or Pop-off.
- **Flow through the optional EZchange Canister and Condenser:** EZchange ON and EZchange OFF (CO_2 bypass).

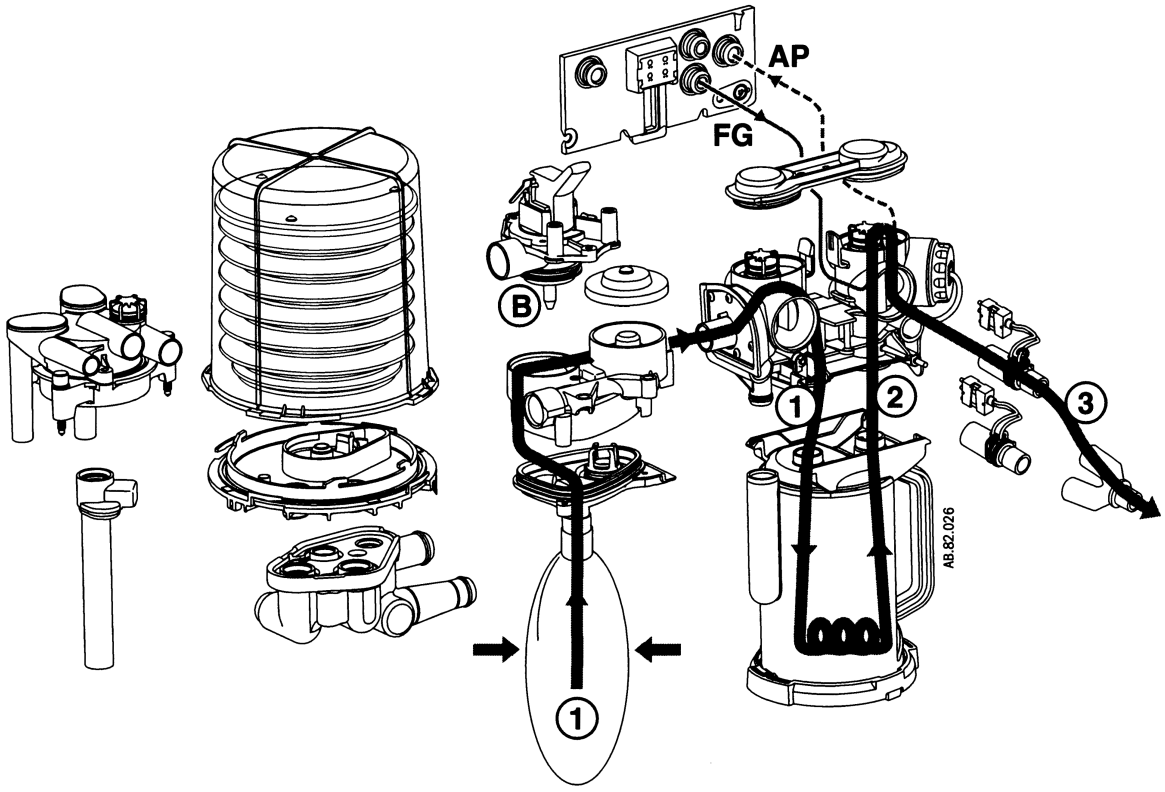
2.3.2 Manual ventilation

Manual Inspiration

The Bag/Vent switch closes the ventilator path (**B**).

Gas flows from the bag (**1**), through the absorber (**2**), into the breathing circuit module, and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas (**FG**) flows from the machine into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
B	Bag/Vent switch to Bag
FG	Fresh Gas
1	Flow to absorber
2	Flow from absorber
3	Inspiratory flow

Figure 2-4 • Gas flow during manual inspiration

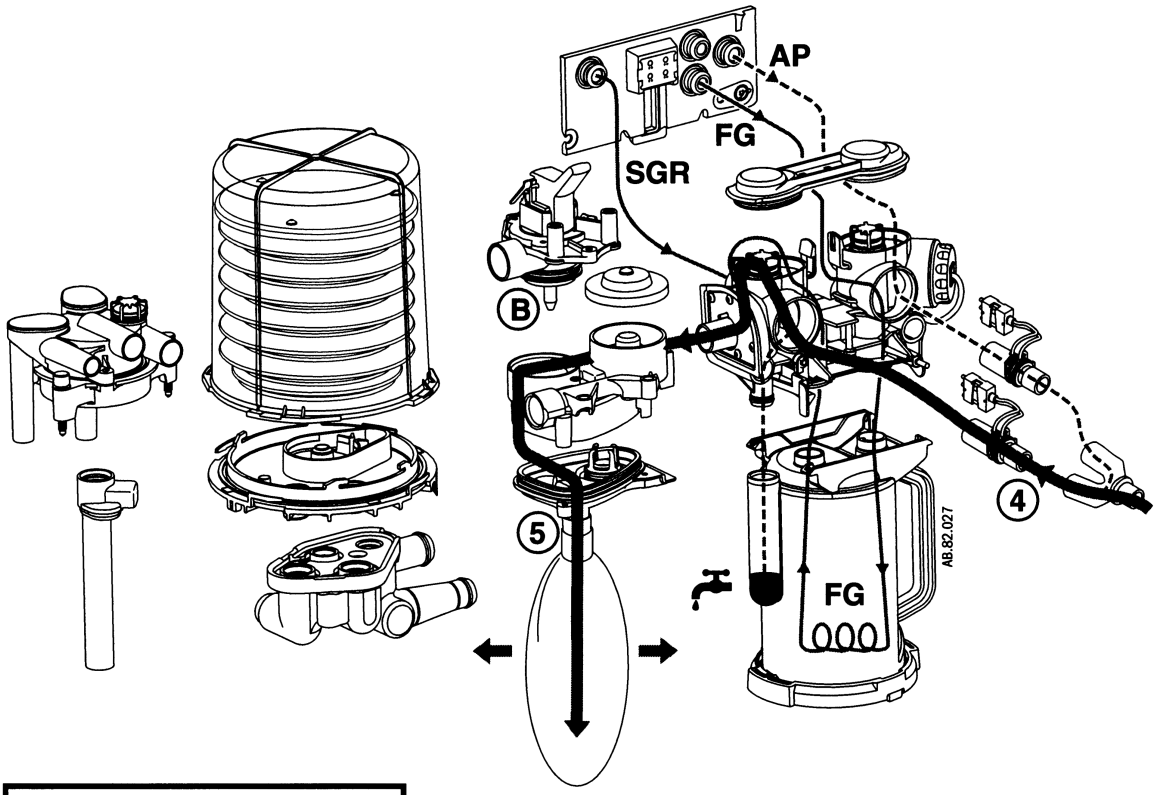
Manual expiration

The Bag/Vent switch keeps the ventilator path closed (**B**).

Gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve), and into the bag (**5**).

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.

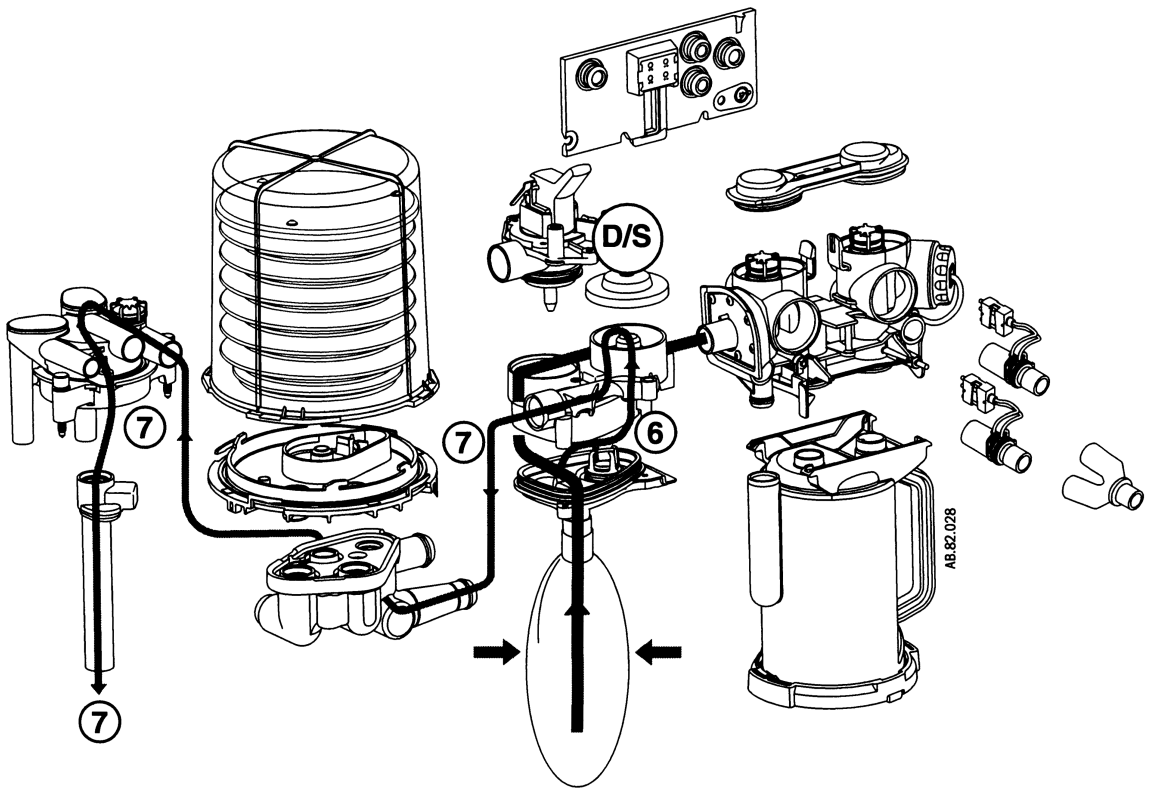


AP	Airway Pressure
B	Bag/Vent switch to Bag
FG	Fresh Gas
SGR	Sample Gas Return
4	Expiratory flow
5	Flow to bag

Figure 2-5 • Flow during manual expiration

APL Valve The APL valve sets a pressure limit for manual ventilation.

As you turn the APL knob, it puts more or less force on the APL disc and seat (**D/S**). If the circuit pressure is too high (**6**), the disc and seat inside the diaphragm opens and vents gas to the scavenging system (**7**).



D/S	APL disc and seat
6	APL flow
7	To scavenging

Figure 2-6 • Flow through the APL Valve

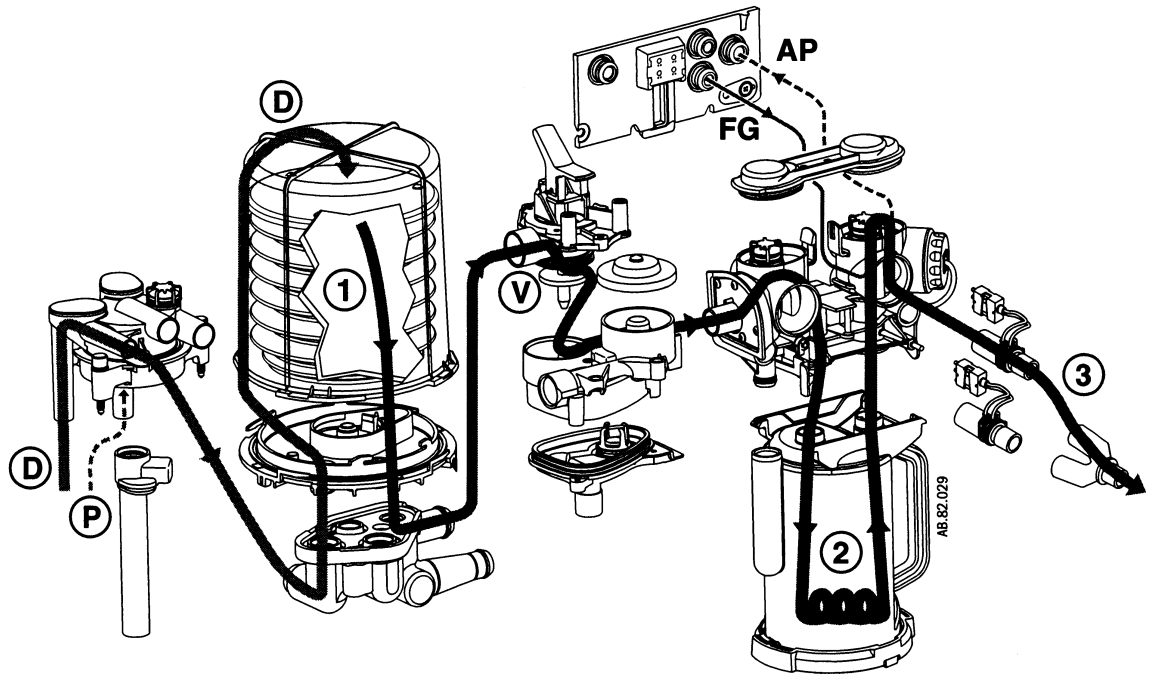
2.3.3 Mechanical ventilation

Mechanical inspiration

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2	Flow from absorber
3	Inspiratory flow

Figure 2-7 • Mechanical inspiration

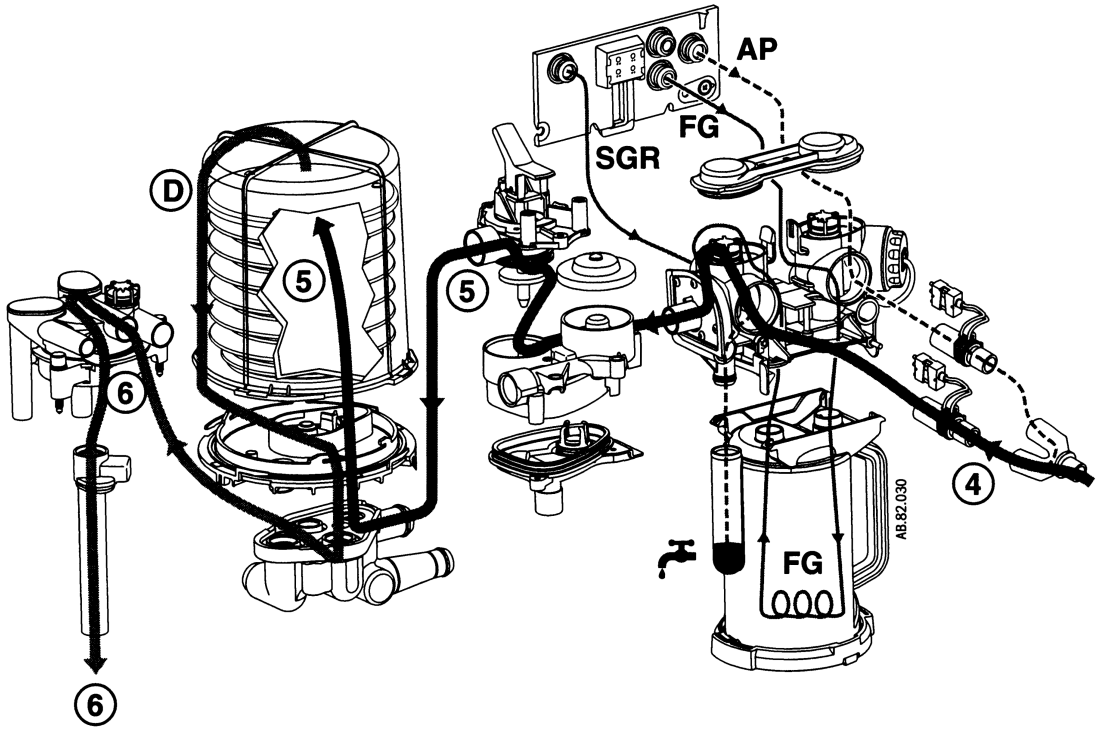
Mechanical expiration

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
SGR	Sample Gas Return
4	Expiratory flow
5	Flow to bellows
6	To scavenging

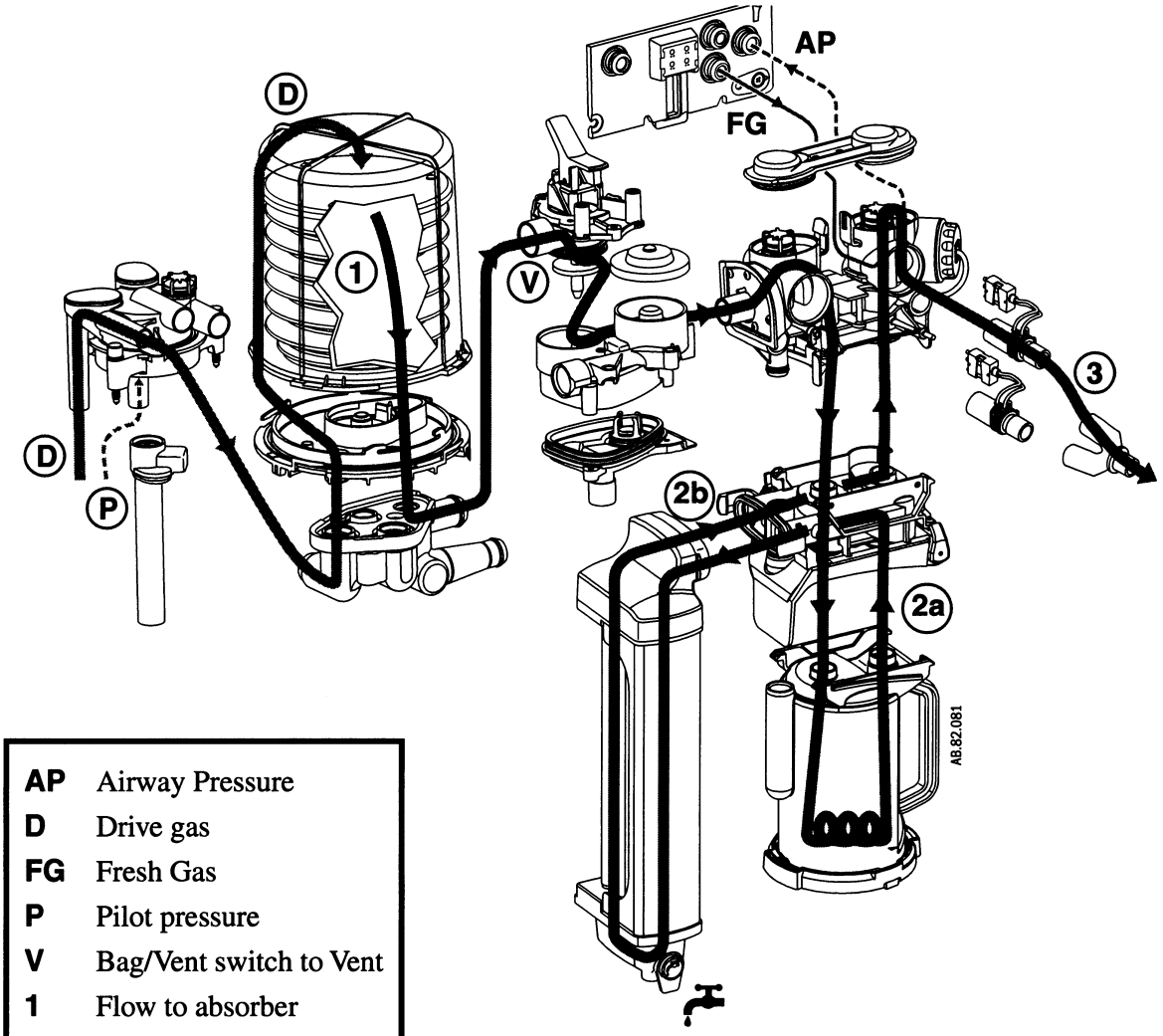
Figure 2-8 • Mechanical expiration

Mechanical Inspiration (EZchange and condenser ON)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2a**), Condenser (**2b**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2a	Flow from absorber
2b	Flow from condenser
3	Inspiratory flow

Figure 2-9 • Mechanical inspiration through Condenser with EZchange Canister and Condenser ON

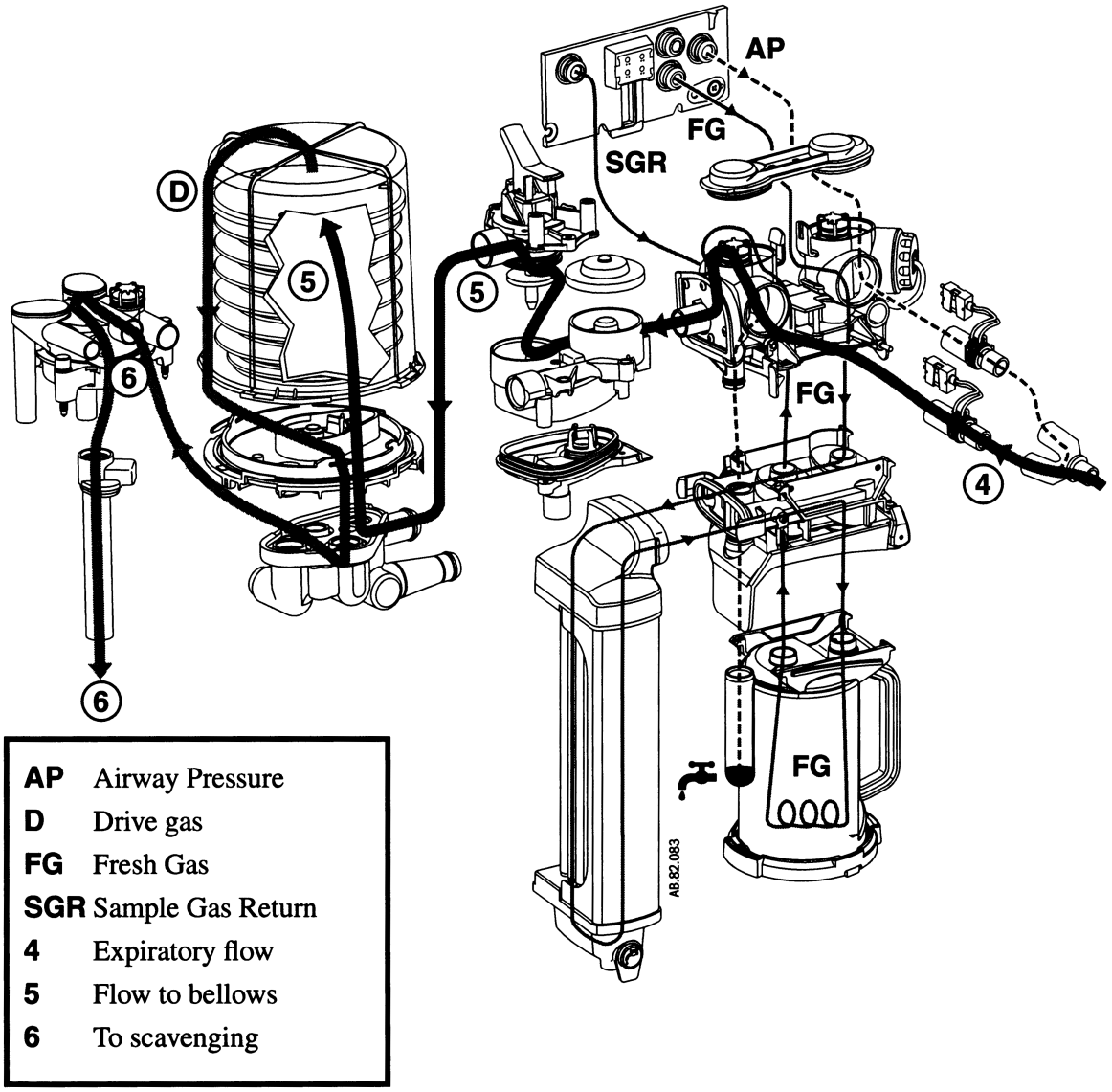
Mechanical expiration (EZchange and condenser ON)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the Condenser and absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
SGR	Sample Gas Return
4	Expiratory flow
5	Flow to bellows
6	To scavenging

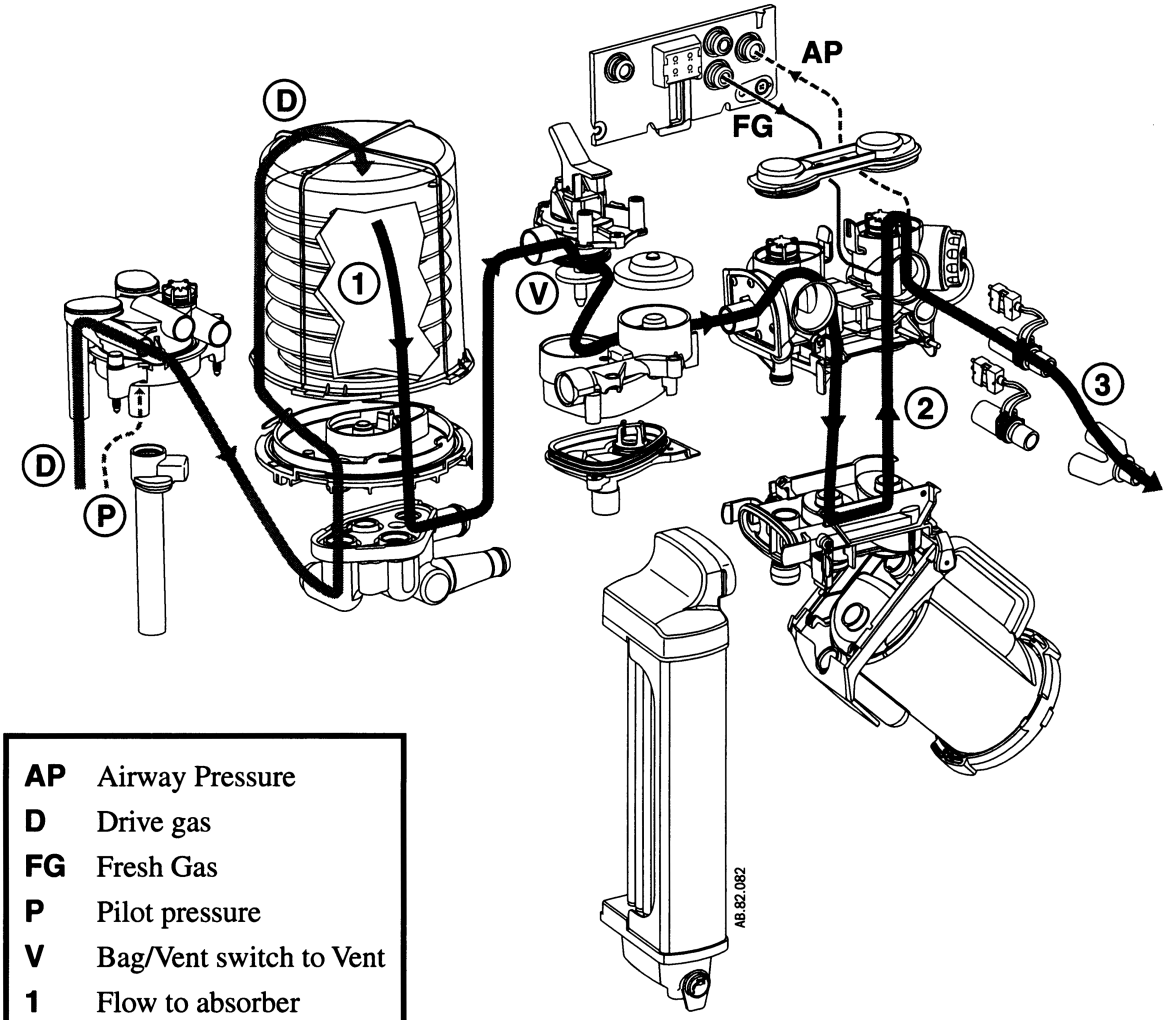
Figure 2-10 • Mechanical expiration through Condenser with EZchange Canister and Condenser ON

Mechanical Inspiration (EZchange and condenser OFF)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the EZchange module bypassing the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2	Bypass flow
3	Inspiratory flow

Figure 2-11 • Mechanical inspiration with EZchange Canister and Condenser OFF

Mechanical expiration (EZchange and condenser OFF)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the EZchange module (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.

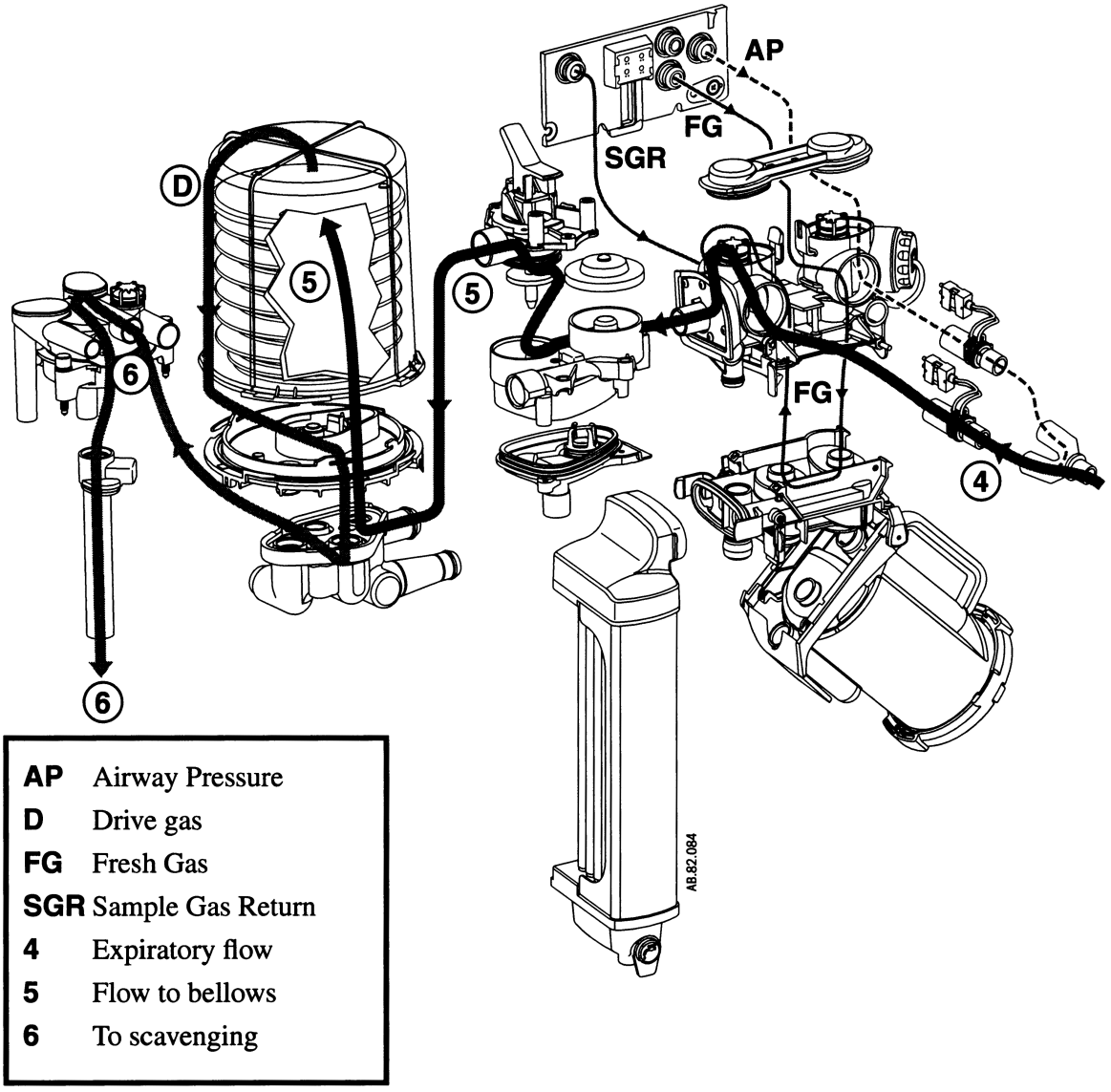
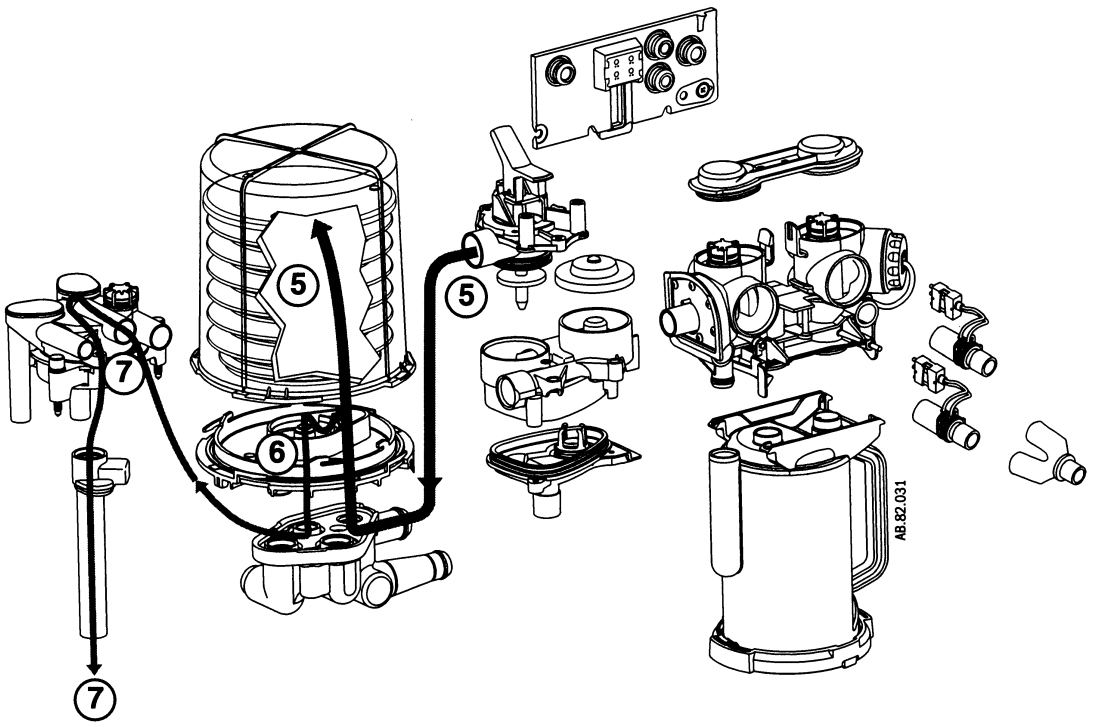


Figure 2-12 • Mechanical expiration with EZchange Canister and Condenser OFF

Pop-off valve

The pop-off valve limits the pressure inside the bellows to 2.5 cm H_2O above the drive gas pressure. This normally occurs when the bellows reaches the top of the housing at the end of exhalation (**5**).

Excess gas (**6**) vents to the scavenging system (**7**) through the pop-off valve and the exhalation valve.



5	Flow to bellows
6	Pop-off flow
7	To scavenging

Figure 2-13 • Flow through the pop-off valve

2.3.4 Fresh gas and O_2 flush flow

To ABS breathing system

Fresh gas (**1**) flows from the vaporizer manifold outlet to the ACGO Selector Switch.

With the ACGO Selector Switch in the ABS position, fresh gas flow is channeled to the breathing system through port 3.

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the ACGO Selector Switch.

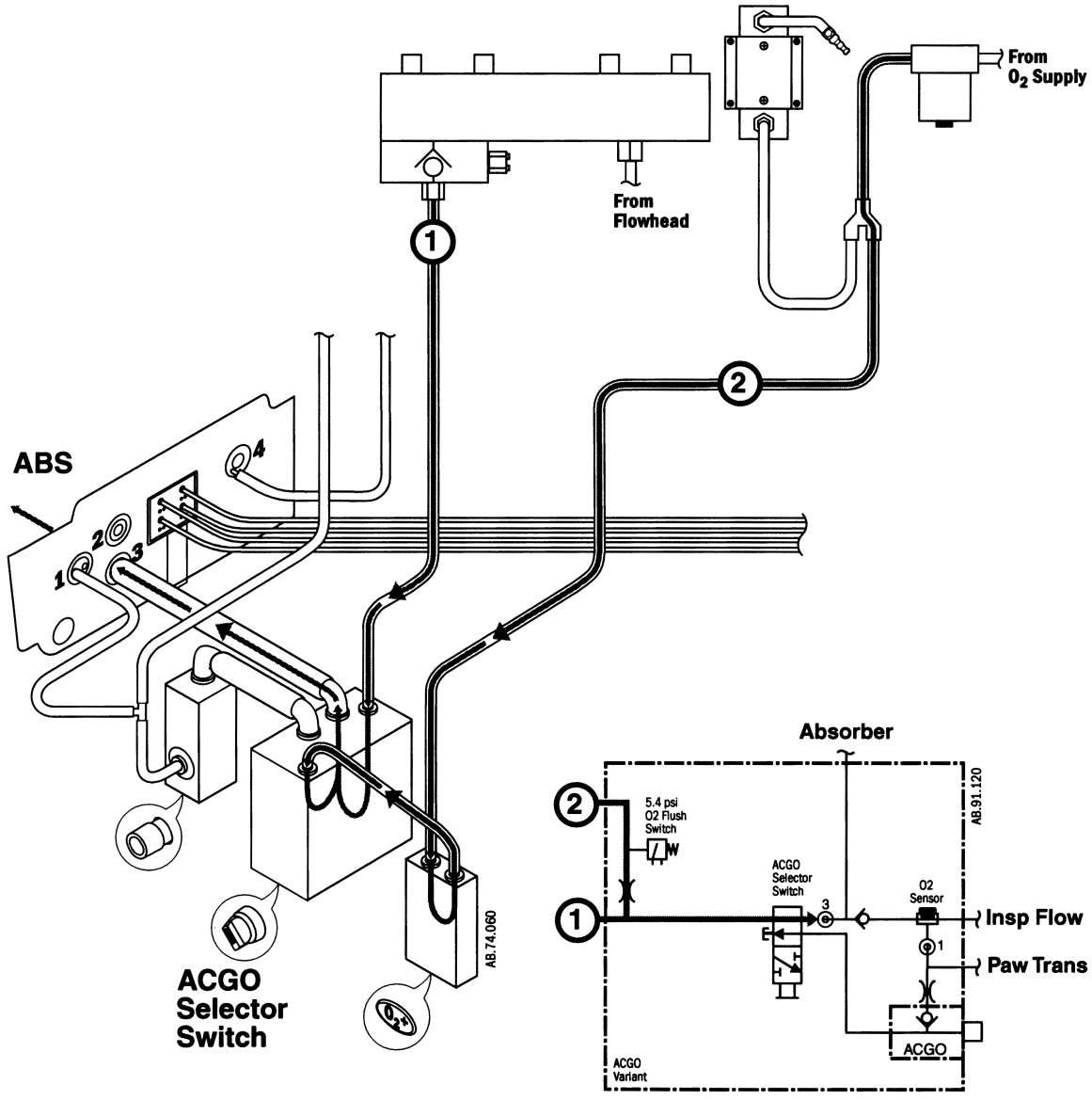


Figure 2-14 • Fresh gas and O_2 flush flow (to ABS)

Auxiliary Common Gas Outlet

Fresh gas (**1**) flows from the vaporizer manifold outlet to the ACGO Selector Switch.

With the ACGO Selector Switch in the ACGO position, fresh gas flow is channeled to the ACGO outlet.

At the ACGO outlet, a small sample is diverted to the O_2 Sensor in the ABS for O_2 monitoring.

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the ACGO Selector Switch.

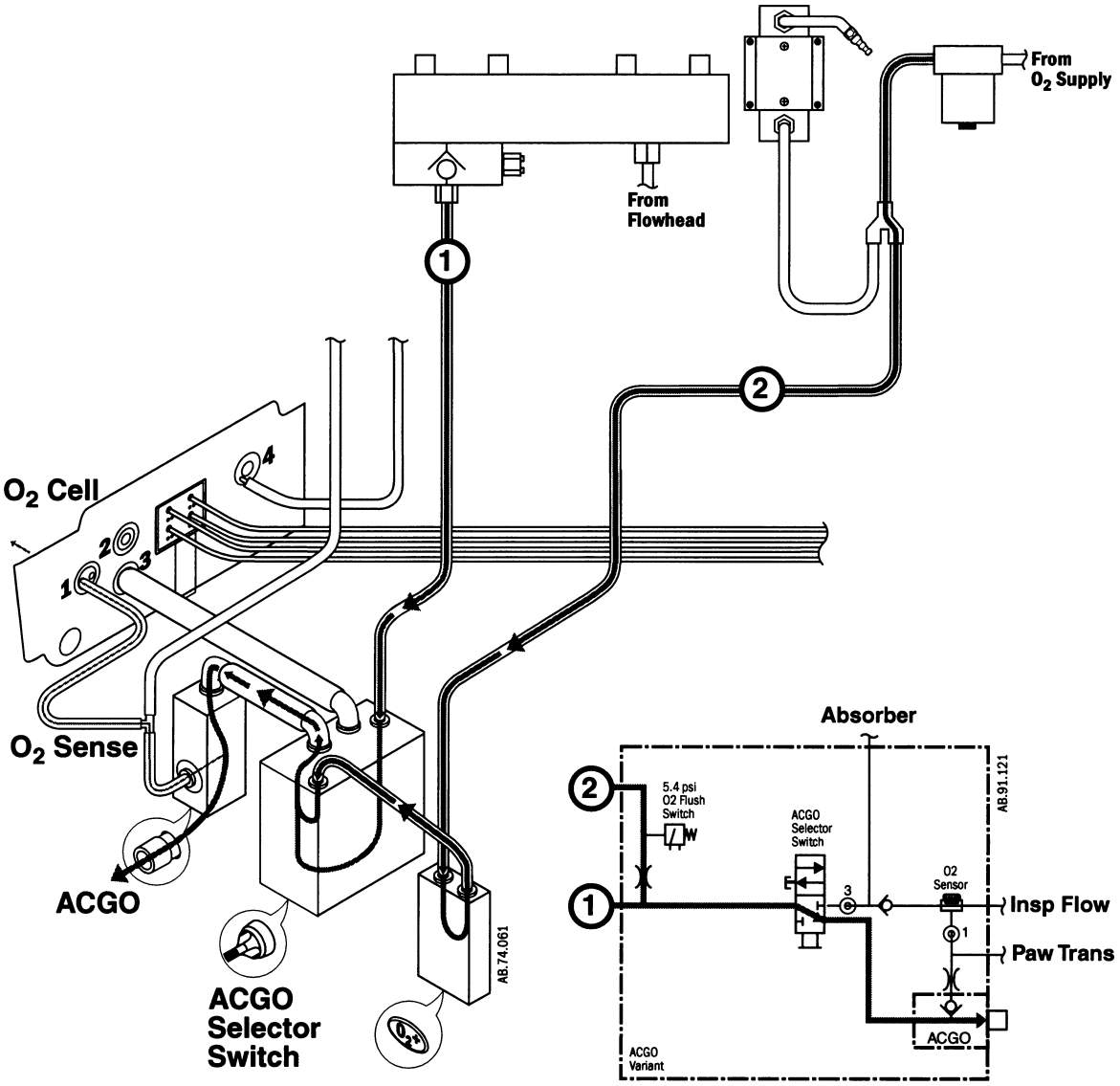
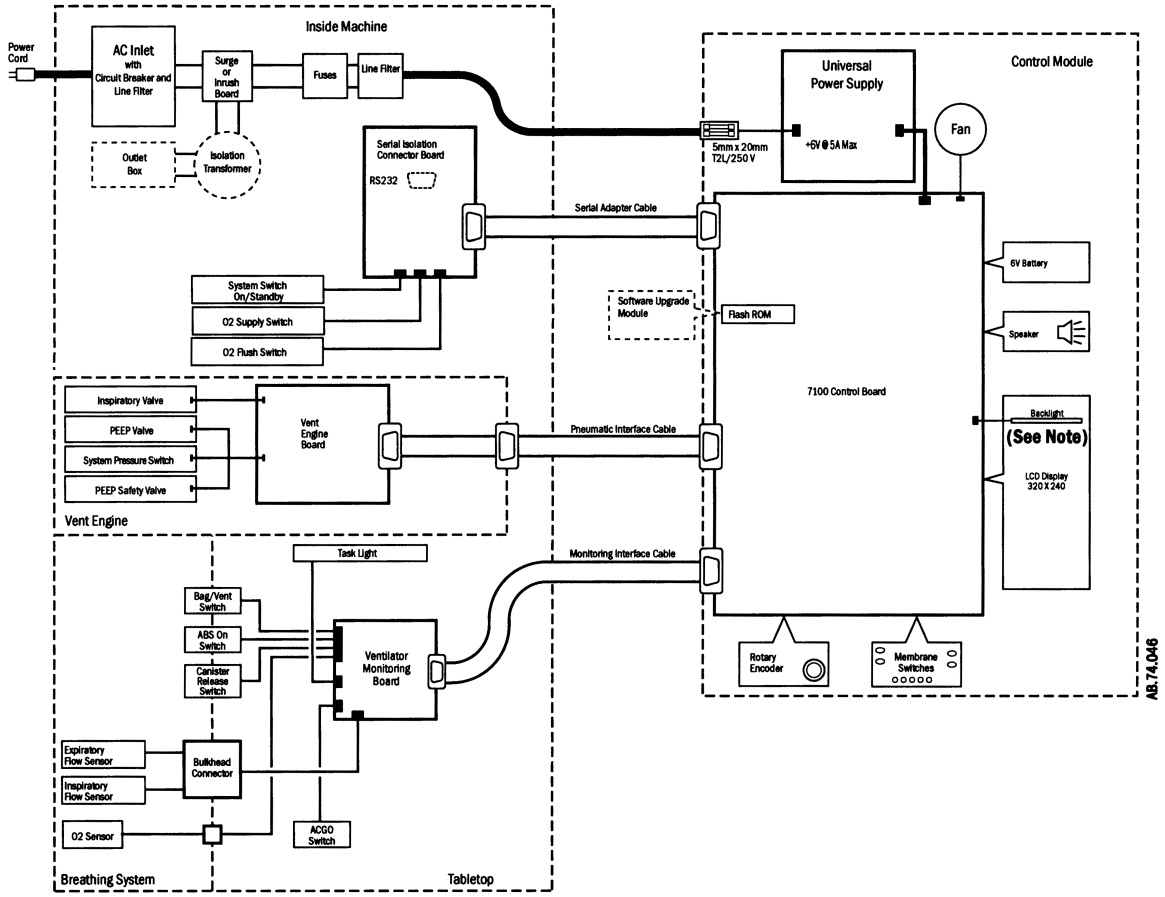


Figure 2-15 • Fresh gas and O_2 flush flow (to ACGO)

2.4 General Description

The 7100 ventilator is a microprocessor based, electronically-controlled, pneumatically-driven ventilator with a built-in monitoring system for inspired oxygen, airway pressure and exhaled volume. The ventilator is an integral component of the Aespire anesthesia machine.



Note: For non-color displays, the backlight is powered through the control board, as shown. For color displays, the control module includes a separate circuit board to power the backlight.

Figure 2-16 • 7100 ventilator functional block diagram

2.5 7100 ventilator features

- Sensors in the breathing circuit are used to control and monitor patient ventilation and measure inspired oxygen concentration. This lets the ventilator compensate for compression losses, fresh gas contribution, valve and regulator drift and small leakages in the breathing absorber, bellows and system.
- Positive End Expiratory Pressure (PEEP) is generated electronically. PEEP is not active when mechanical ventilation is off.
- User settings and microprocessor calculations control breathing patterns. User interface settings are kept in non-volatile memory.
- Mechanical ventilation is started with the Bag/Vent switch on the breathing system.
- The 7100 ventilator has minimum monitoring and alarms managed on the ventilator panel (there is no other panel for safety relevant alarm management, etc.).
- Ventilator hardware is regularly monitored by software tests.
- An RS-232 serial digital communications port connects to and communicates with external devices.
- An exhalation valve modulates flow in the pressure mode.
- Pressure and volume modes are selectable by the operator.
- All pneumatic components are located on one manifold.
- Exhausted drive gas and bellows pressure relief valve gases are mixed and go through the ventilator exhalation valve.
- The exhalation valve block is autoclavable.
- Excess fresh gas released from the bellows and ventilator drive gas are transferred from the exhalation valve to the Anesthesia Gas Scavenging System (AGSS).
- Optimized for service with a low number of components.

2.5.1 Safety features

- Dual redundant airway overpressure protection, linked to Plimit setting.
- Volume over-delivery limits and protection.
- Proprietary hose connections and fixed manifolds.
- Proven mechanical components used.
- 10 VA electrical power limiting to potential oxygen enriched environment.
- 150 psi burst overpressure protection.

2.6 7100 ventilator components

Major components of the 7100 ventilator are found in different locations of the anesthesia machine.

The ventilator package consists of:

1. a Control Module (CM) – (color or non-color display) – the CM includes:
   - a Control Board (CB)
   - an LCD Display
   - a Keyboard (with rotary encoder switch)
   - a Power Supply
   - a backup battery
2. a Ventilator Monitoring Board (VMB).
3. a Serial Isolation Connector Board (SICB).
4. a Vent Engine (VE) with a Vent Engine Board (VEB).

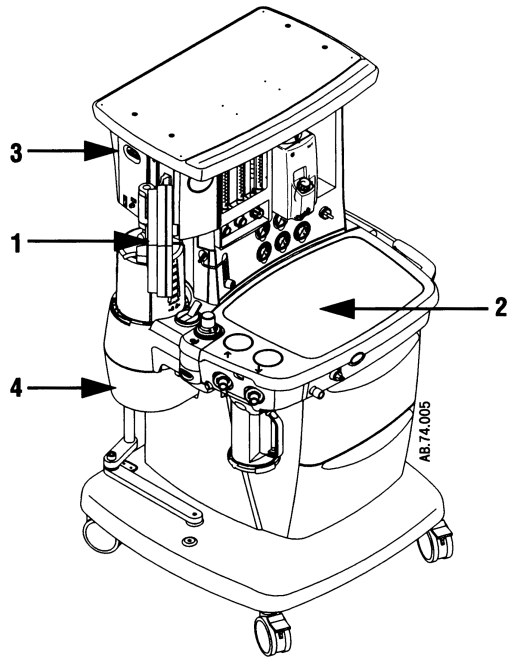


Figure 2-17 • Location of 7100 ventilator components

2.6.1 Control Module (color display)

The control module with a color display consists of two enclosures.

The rear enclosure includes:

1. inline fuses
2. a power supply
3. a cooling fan
4. a backup battery

The power supply receives AC power from the anesthesia machine. All the power necessary to operate the ventilator comes from the power supply.

The front enclosure includes:

5. a control board (controls operation of the ventilator)
6. a backlight inverter
7. an LCD display
8. a keyboard front panel
9. a rotary encoder
10. a speaker

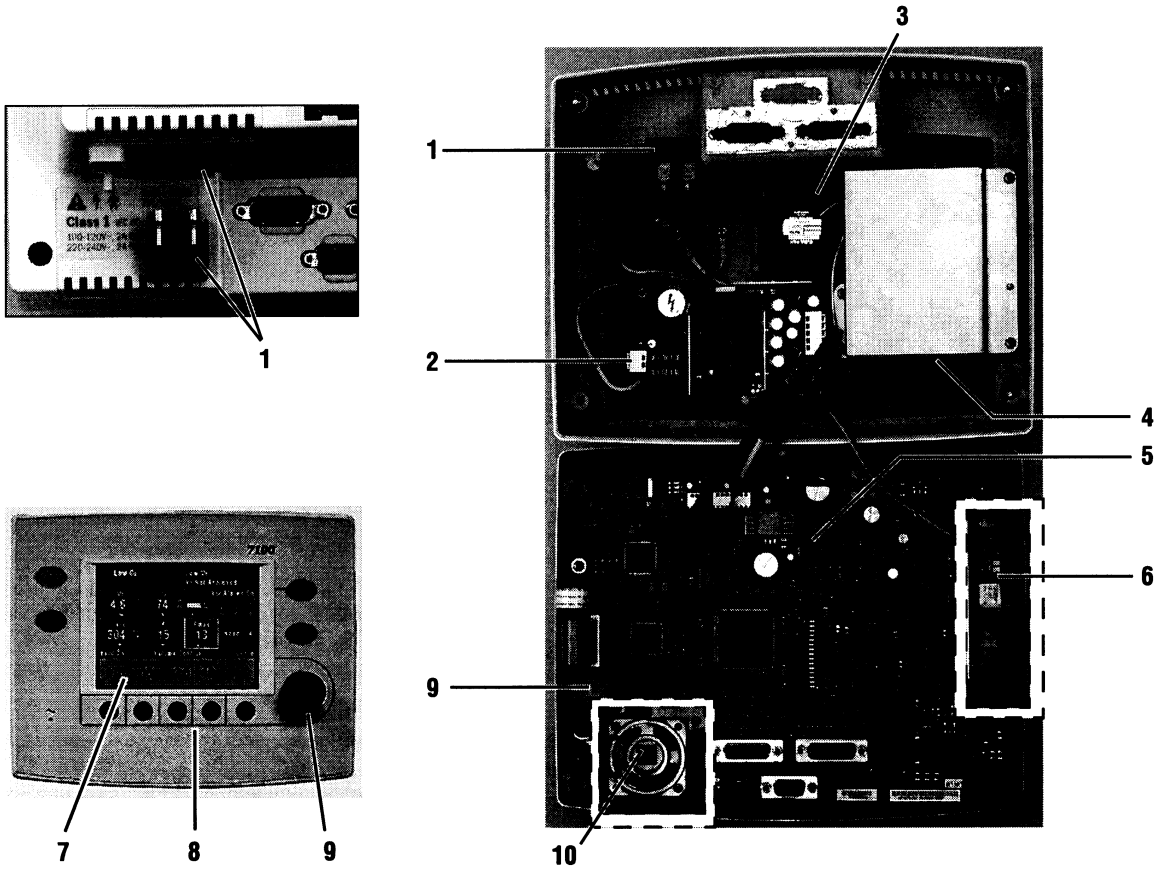


Figure 2-18 • 7100 ventilator control module

2.6.2 Control Module (non-color display)

The control module with a non-color display consists of two enclosures.

The rear enclosure includes:

1. inline fuses
2. a power supply
3. a cooling fan
4. a backup battery

The power supply receives AC power from the anesthesia machine. All the power necessary to operate the ventilator comes from the power supply.

The front enclosure includes:

5. a control board (controls operation of the ventilator)
6. a front panel assembly

The front panel assembly includes four submodules:

7. an LCD display
8. a keyboard front panel
9. a rotary encoder
10. a speaker

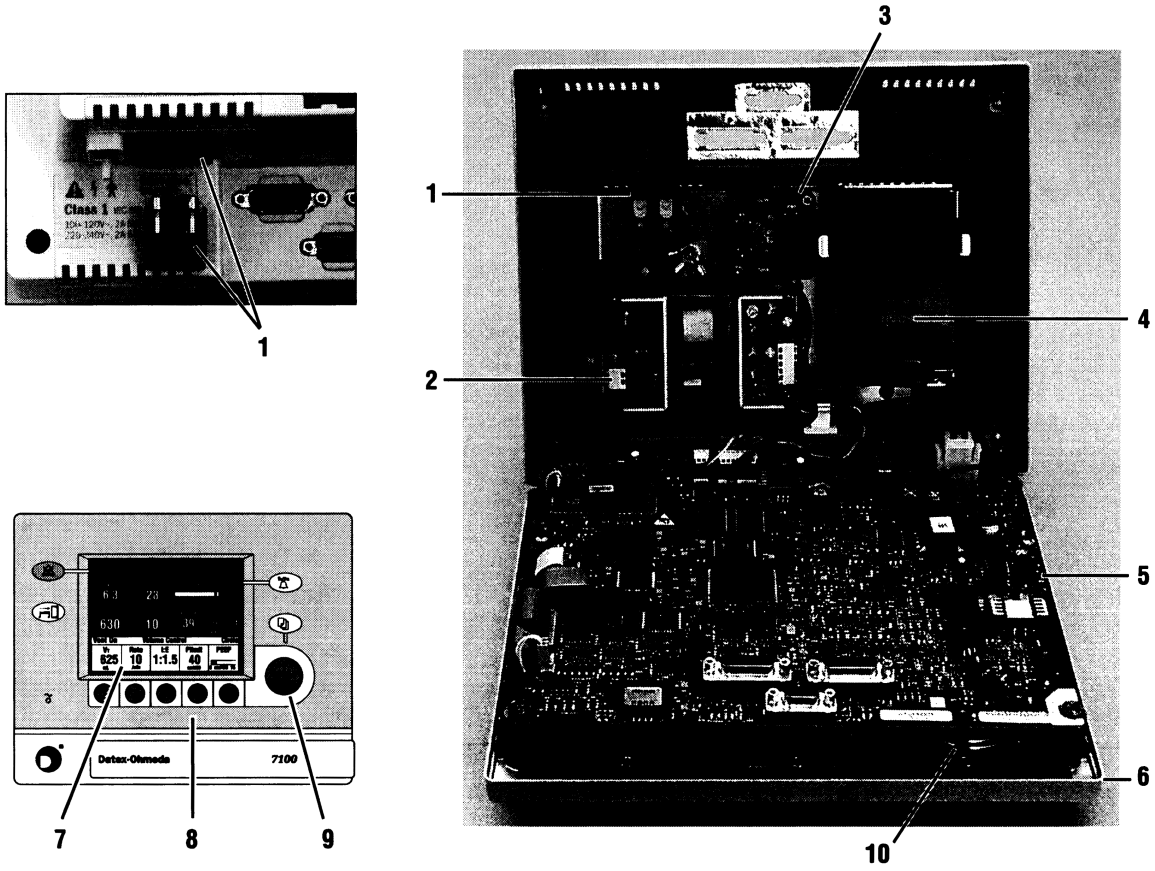
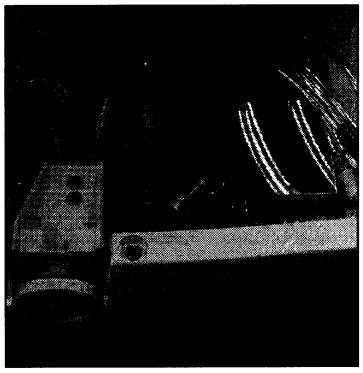


Figure 2-19 • 7100 ventilator control module

2.6.3 Monitoring Interface

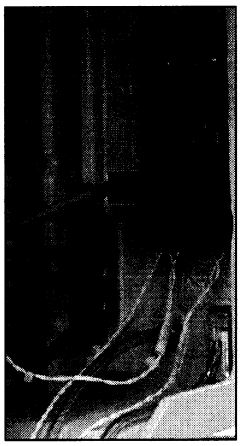


The Ventilator Monitoring Board (VMB) serves as the interface between the ventilator's control board and the breathing system sensors and switches:

- the inspiratory and expiratory flow sensors
- the O_2 sensor
- the Bag/Vent switch
- the VMB is hardwired to indicate a Circle module
- the canister release switch
- machines that include the canister release switch are hardwired to show software the presence of an EZchange (CO2 Bypass) canister assembly
- the "control panel switch" signal in an Aespire machine indicates whether the ABS breathing system is engaged or disengaged
- the Auxiliary Common Gas Outlet (ACGO) switch
- task light power

The VMB is located under the tabletop (below the worksurface). Machines that do not include monitoring use a depopulated board (Task Light Interface Board – TLIB) to power the task light and to interface the breathing system switches.

2.6.4 Serial interface



The Serial Interface and Connection Board (SICB) provides two functions. It serves as the interface between the ventilator's control board and additional switches located in the machine and channels serial communications signals from the controller board to the RS232 connector.

The machine switches include:

- the System On/Standby switch
- the O_2 supply pressure switch
- the O_2 flush switch

The SICB also provides an on/off signal from the system switch to a remote monitor through the RS232 connector.

2.6.5 The Pneumatic Vent Engine

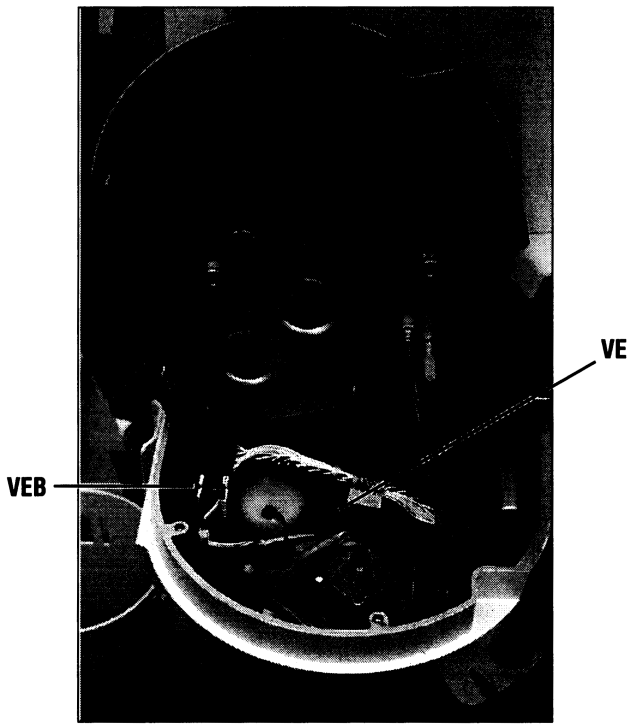
The pneumatic engine enclosure is located in the back chamber of the breathing system and is shielded to contain EMI emissions. The enclosure includes the pneumatic Vent Engine (VE) and a pneumatic Vent Engine control Board (VEB).

The pneumatic Vent Engine consists of the hardware that drives the ventilator bellows. It includes:

- a 2-micron inlet filter
- a pressure regulator
- a proportional inspiratory valve
- a mechanical overpressure relief valve
- a free-breathing check valve
- a PEEP safety valve
- a supply pressure sense switch
- a proportional PEEP valve
- a 200 mL reservoir
- a calibrated bleed orifice

The pneumatic Vent Engine Board is an interface between the engine components and the control board and includes:

- an airway pressure transducer

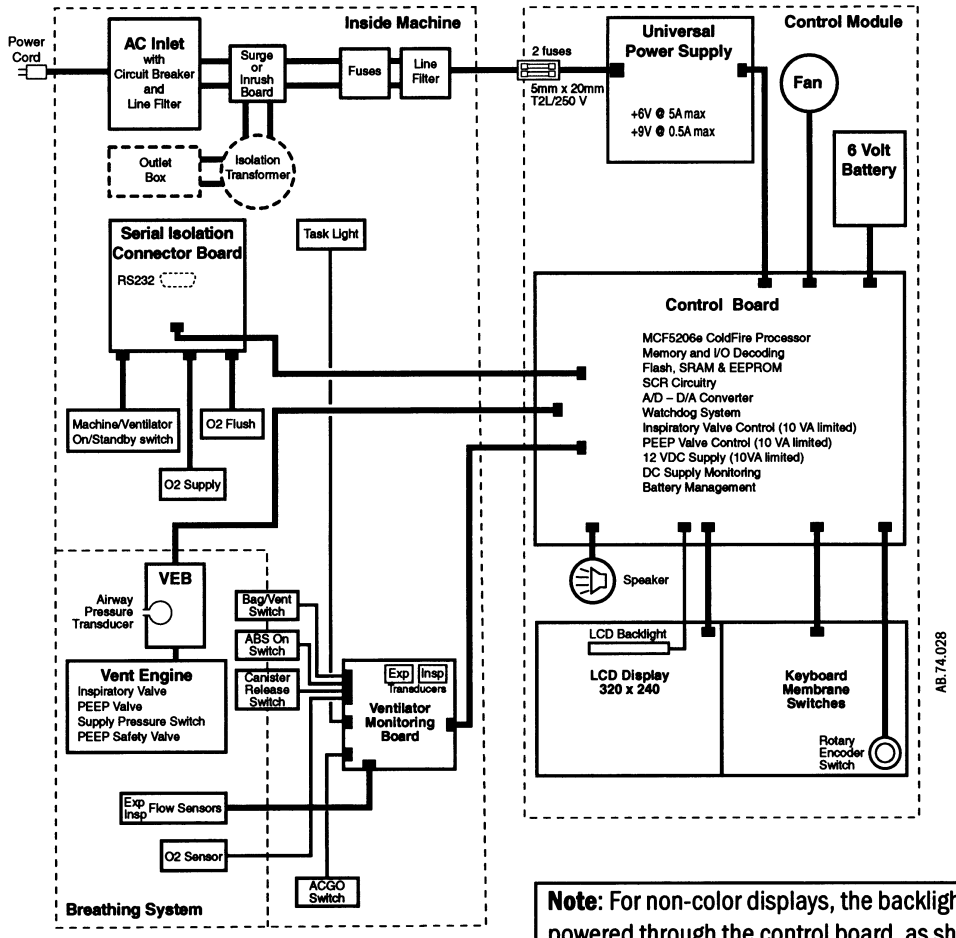


2.7 Electronic and electrical components

2.7.1 The Aespire 7100 ventilator functional blocks

The Aespire 7100 Ventilator electronic/electrical subassemblies or modules include:

- a **Power Supply** for operation under line power and a **backup battery** for limited operation in case of power failure;
- a **Control Board** with digital, analog and power circuits to manage all operations of the ventilator;
- a **Front Panel Assembly** that includes an **LCD display** for display of all ventilation and monitoring parameters and a **keyboard** for operator input;
- a **Ventilator Monitoring Board** to preprocess patient circuit parameters and to channel the breathing system switch states;
- a **Serial Isolation Connection Board** to channel machine switch states and to provide a RS232 serial output for external communication.



Note: For non-color displays, the backlight is powered through the control board, as shown. For color displays, the control module includes a separate circuit board to power the backlight.

Figure 2-20 • Electronic functional block diagram as used in an Aespire machine

2.7.2 Power Supply

The power supply receives AC input from the machine's AC Inlet Module. The power supply is a universal 40 watt switching supply that outputs two DC voltages. The DC voltages are routed to the Control Board where they are further regulated to produce the power requirements for the 7100 ventilator system.

- **Input:**
  Universal 85-264 VAC 47-63 Hz
- **Output V1:**
  6.0 VDC (±0.5%) at 0-5 A
- **Output V2:**
  9.0 VDC (±5%) at 0-0.5 A

⚠ WARNING High voltage in area of ϟ symbol.

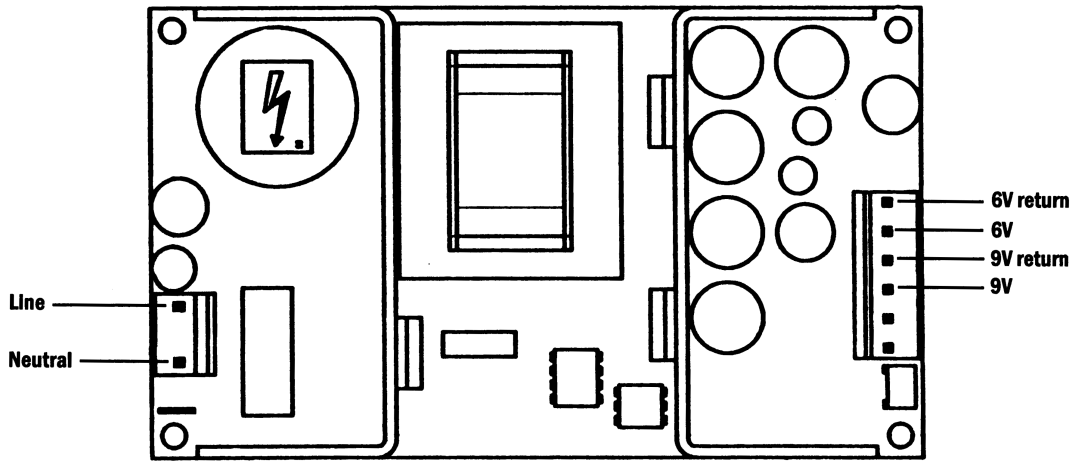


Figure 2-21 • 7100 Ventilator power supply

2.7.3 Sealed Lead Acid Battery

A sealed lead acid battery supplies battery backup for the 7100 ventilator. Since it only provides power in case of a power failure, the battery is in a float charge state most of the time.

The battery meets the following:

- capacity to operate ventilator system for 30 minutes (fully charged);
- long float charge life;
- the battery is internally fused (auto-resettable).

Input: Nominally 6.8 VDC at 25°C during float charge.

Output: +0.6 to +6 Amps during discharge

2.7.4 Control Board

The Control Board contains all of the major circuit functions necessary to control ventilator operation.

The Control Board comprises three functional circuit types:

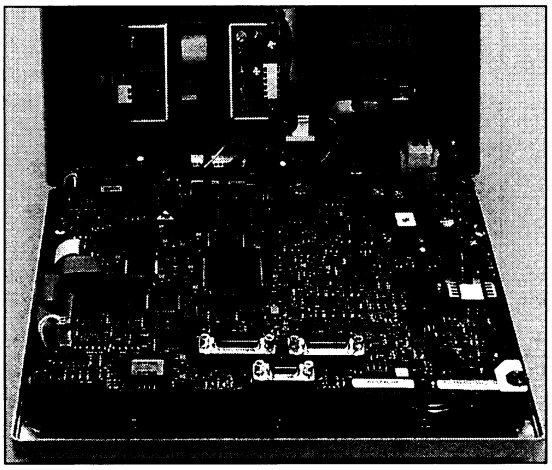
- power circuits,
- analog circuits,
- digital circuits.

These circuits are detailed individually in the following sections.

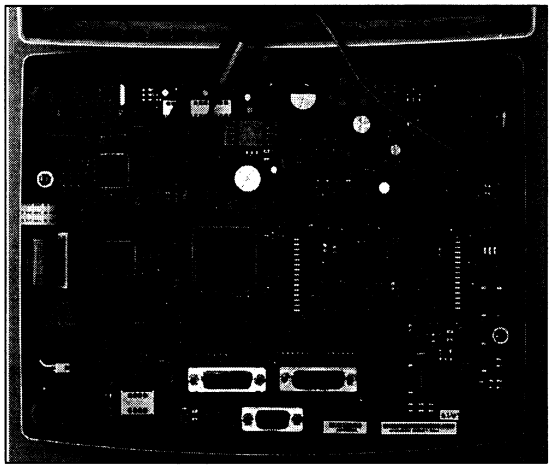
Note: The functions supported by the color and non-color control boards are identical. The circuit descriptions that follow apply to both control boards, except where differences are noted to support the color display.

Overall, the Control Board's functions include:

- Bus access control signals for all memory and peripheral devices
- Interrupt handling
- Clocks and timers for the system
- RS232C serial I/O
- Baud rate generator for serial port
- Hard (power-up) and soft (watchdog error) reset generation
- Data bus buffers
- Memory and I/O decoding
- Program memory with "memory stick" software upgrade
- Safety Relevant Computing (SRC)
- Watchdog system
- Data acquisition
- Flow valve control
- PEEP valve drive and PEEP safety valve drive
- Front panel interface
- Audio alarm



Control Board – non-color display



Control Board – color display

Control Board Power Circuits

The power section of the controller board receives the 6 VDC and the 9 VDC outputs from the power supply.

The 9 VDC supply is used to charge the backup battery.

The 6 VDC supply is processed further to supply various power requirement throughout the 7100 ventilator. In case of power failure, the battery is switched in to supply power.

- power to drive the fan (5V)
- 5V supply for digital circuits
- 3.3V supply for the CPU
- 5V supply for the LCD display backlight
- supply for the LCD display contrast adjustment
  - -24V adjustable (non-color display)
  - 1.3V to 2.3V adjustable (color display)
- 1.5A supply for control of the Inspiratory and PEEP valves
- +12V supply for analog circuits
- +12V supply for the Monitoring Interface Assembly
- -12V supply for analog circuits

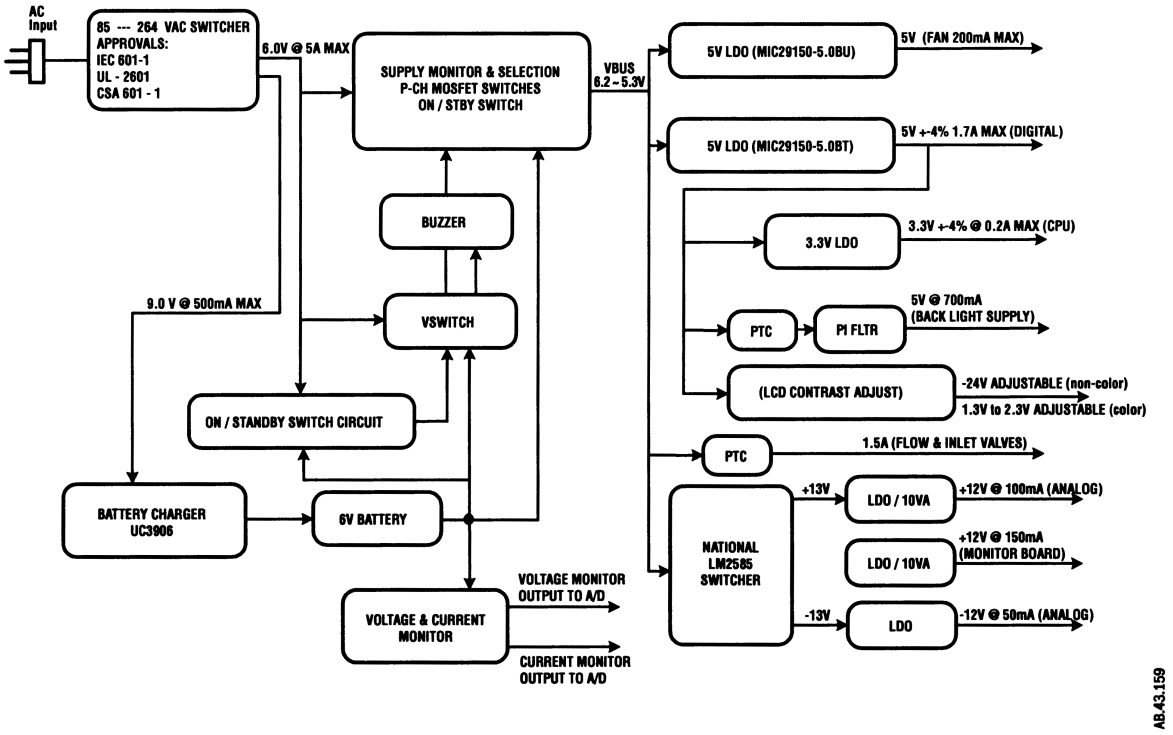


Figure 2-22 • Control board block diagram - Power circuits

Control Board Analog Circuits

The analog section of the controller board processes inputs from the Monitoring Interface Board and the Pneumatic Engine Board. It multiplexes the inputs for display by the digital section.

- Inspiratory flow
- Expiratory flow
- Airway O_2
- Airway pressure

Under the control of the digital section, the analog section includes drivers for the pneumatic engine components:

- flow valve (inspiratory valve)
- PEEP valve
- PEEP safety valve

The switch signals from the Monitoring Interface Board and the supply pressure signal from the Pneumatic Engine Board are passed on as inputs to the digital section.

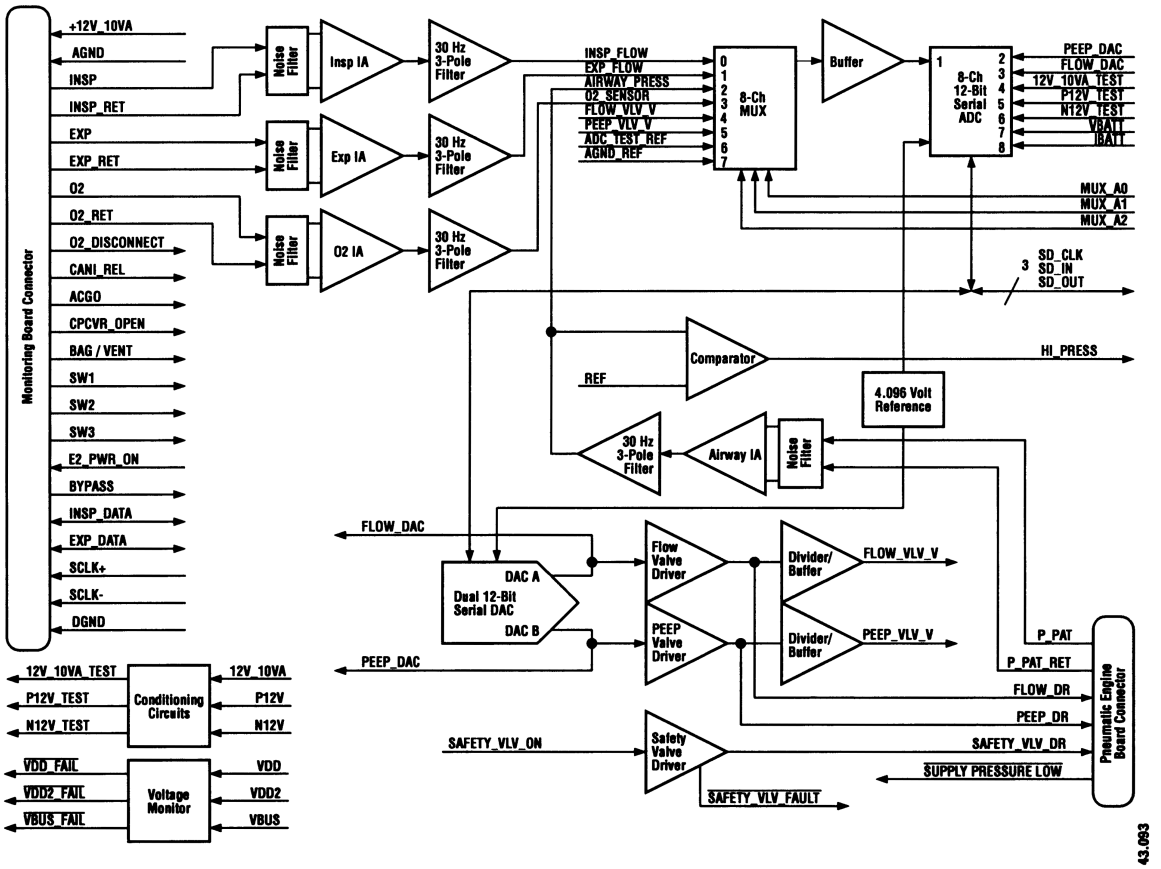


Figure 2-23 • Control board block diagram - Analog circuits

Control Board Digital Circuits

The digital section of the controller board includes a MCF5206e ColdFire microcontroller. The Aespire 7100 operating software is stored in 2MB of 8-bit (1Mx16) Flash ROM. The board includes:

- 1MB of 8-bit (512Kx16) static RAM (SRAM) for operation,
- and (*32Kx8 for non-color) or (**64Kx16 for color) CMOS static RAM for processing video information

The controller receives switch inputs from the front panel keyboard and the system inputs from the Vent Monitoring Board, the Serial Isolation Connector Board and the Vent Engine Board.

The patient circuit parameters are multiplexed through the analog section.

The LCD Display is driven through the Video Controller. It displays the processed patient circuit parameters along with the derived alarm and system condition messages.

Additional outputs include an audio amplifier to drive the speaker and a RS232 driver for external communication through the Serial Isolation Connector Board.

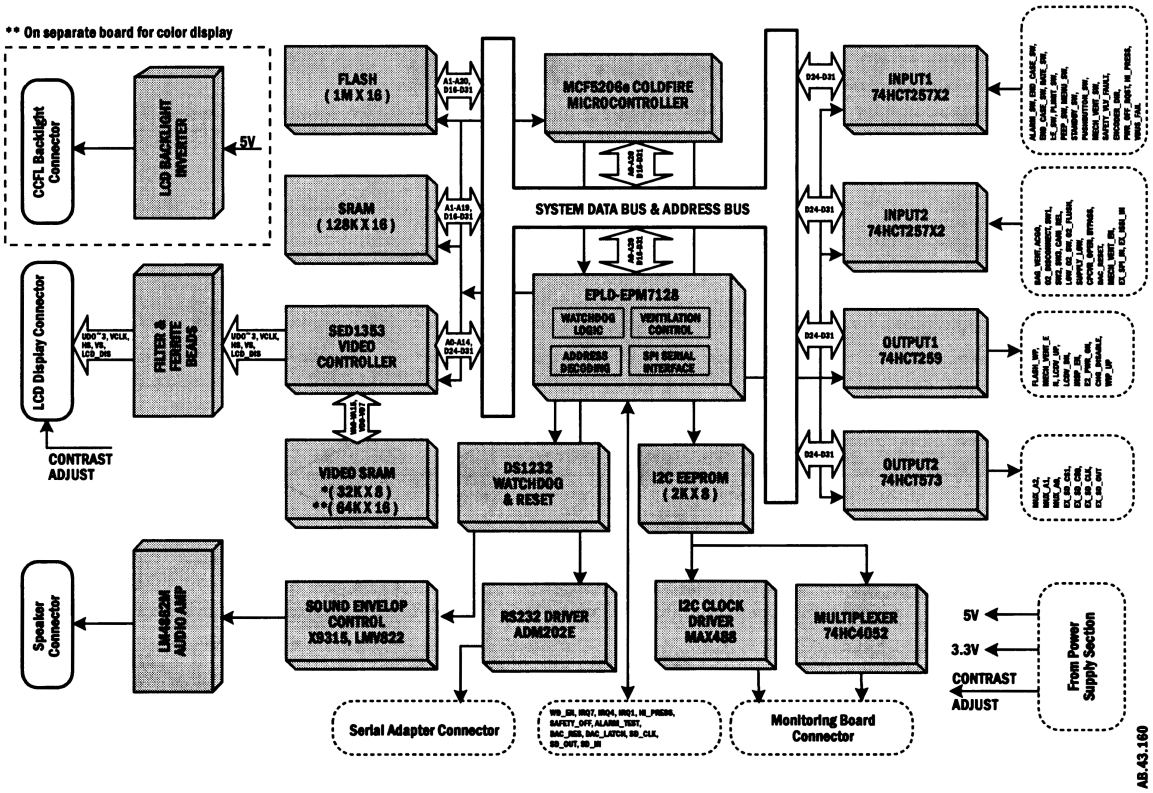


Figure 2-24 • Control board block diagram - Digital circuits

2.7.5 Monitoring Interface

The Vent Monitoring Board (VMB) is the interface between the patient circuit sensors (the inspiratory and expiratory flow sensor, the O_2 sensor) and the ventilator control module. It also passes different switch functions through to the ventilator control module and provides power to the task light.

Respiratory gas flow, to and from the patient, is monitored by measuring the differential pressure across a variable orifice in each flow sensor. The pressure transducers for measuring the differential pressure are on the VMB. Conditioning circuitry is supplied for these transducers and for the Oxygen sensor used in the breathing circuit.

Pressure sense tubing and signal wiring is routed from the sensors and switches in the breathing system to the VMB. A separate cable transfers power and signals to and from the Control Board in the display module.

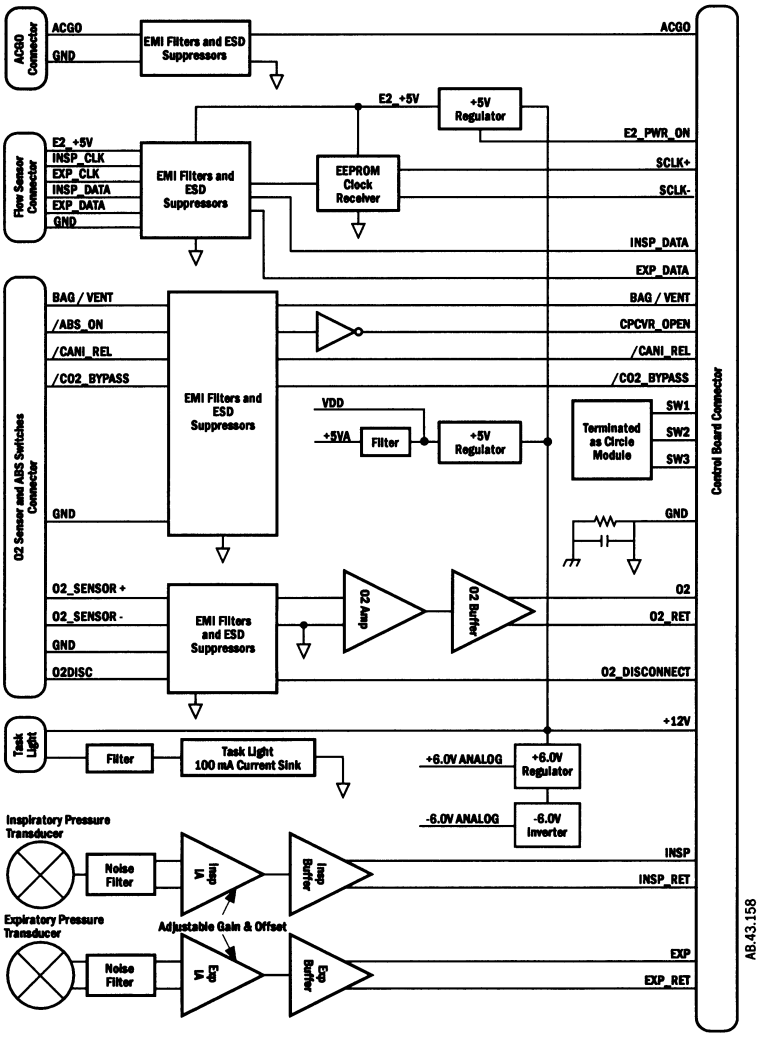


Figure 2-25 • Breathing Circuit Vent Monitoring Board (VMB)

2.7.6 Serial Interface

The Serial Isolation Connector Board (SICB) provides three functions:

- It serves as an interface between the control board and switches that are located in the machine itself (not in the breathing system).
- It processes serial communications signals from the control board to the RS-232 Serial port on the breathing system side of the Aespire machine.
- It provides remote monitor On/Off through an isolated relay.

Machine Switches

The machine switches include:

- the System On/Standby switch
- the O_2 supply pressure switch
- the O_2 flush switch

Serial Communications

The serial interface provides isolated RS232 serial communications. The TXD (transmit) and RXD (receive) signals between the SICB and the control board are at RS-232 levels.

Circuits on the board change the signals to digital 5V levels; isolate them through optocouplers; then, change them back to RS-232 levels before sending them to the outside world.

- The external communications signals conform to standard RS-232C signal standards.
- The external connector is a 15-pin female D connector.
- It is configured for Data Communications Equipment (DCE)
- Pin 6 - Receive data
- Pin 13 - Transmit data
- Pin 5 - Signal ground
- Pin 1 - Monitor On/Standby
- Pin 9 - Monitor On/Standby return

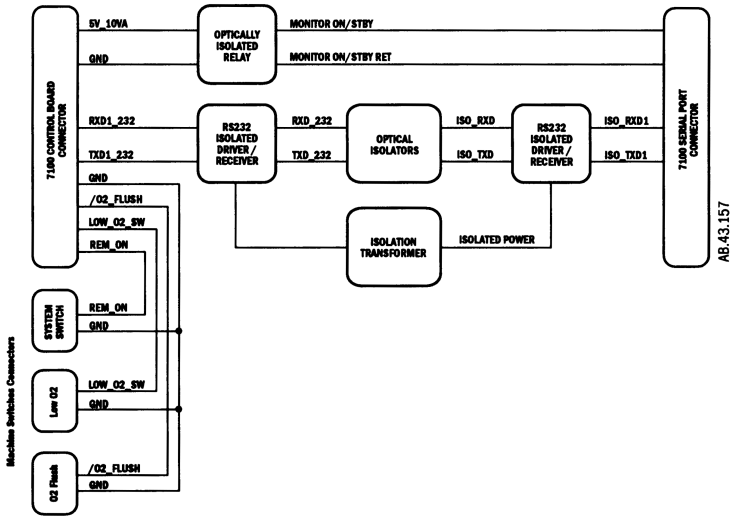


Figure 2-26 • Serial Isolation Connector Board (SICB)

2.7.7 Vent Engine Board

The Vent Engine Board (VEB) provides two functions:

- It serves as an interface between the control board and the pneumatic engine.
- It processes the output from the airway pressure transducer.

Pneumatic Engine Interface

The board provides a direct connection for the drive and return lines for the control valves on the pneumatic engine:

- Inspiratory Flow Valve
- PEEP Valve
- PEEP Safety Valve

The board routes the Supply Pressure Switch signals to the control board.

Airway Pressure Transducer

The VEB includes a +5VA regulator to power the airway pressure transducer circuitry. The circuits provide EMI filtering, signal amplification, and buffering.

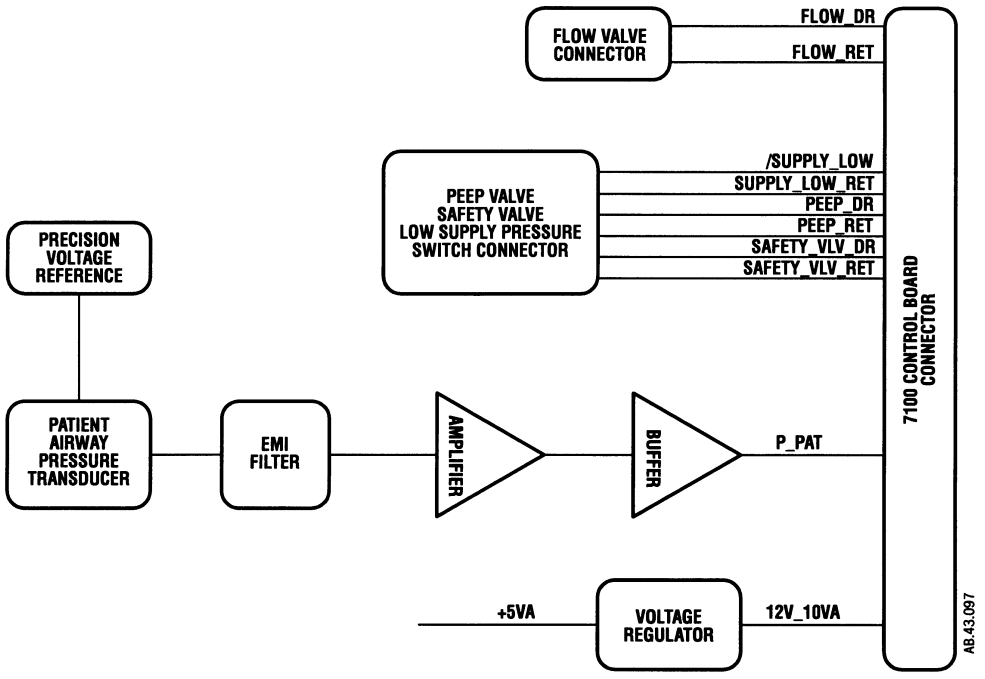


Figure 2-27 • Vent Engine Board (VEB)

2.8 Ventilator mechanical subsystems

Refer to Figure 11-1, "*System connection block diagram*," in Section 11 for the complete pneumatic/mechanical subsystem.

The mechanical subsystem includes:

Pneumatic Vent Engine

- Drive gas inlet filter
- Supply gas pressure regulator
- Inspiratory flow control valve
- PEEP valve; PEEP safety valve; Pressure sense switch
- Mechanical Overpressure Valve (MOPV)
- Bleed resistor
- Free breathing valve

Exhalation valve

Bellows assembly

Breathing circuit flow sensors

2.8.1 Drive gas

Drive gas (can be selected from O_2 or Air) enters the Vent Engine (**1**) at a pressure of 241 to 690 kPa (35 to 100 psi) through a 2-micron filter (**2**) that is located under the gas inlet fitting.

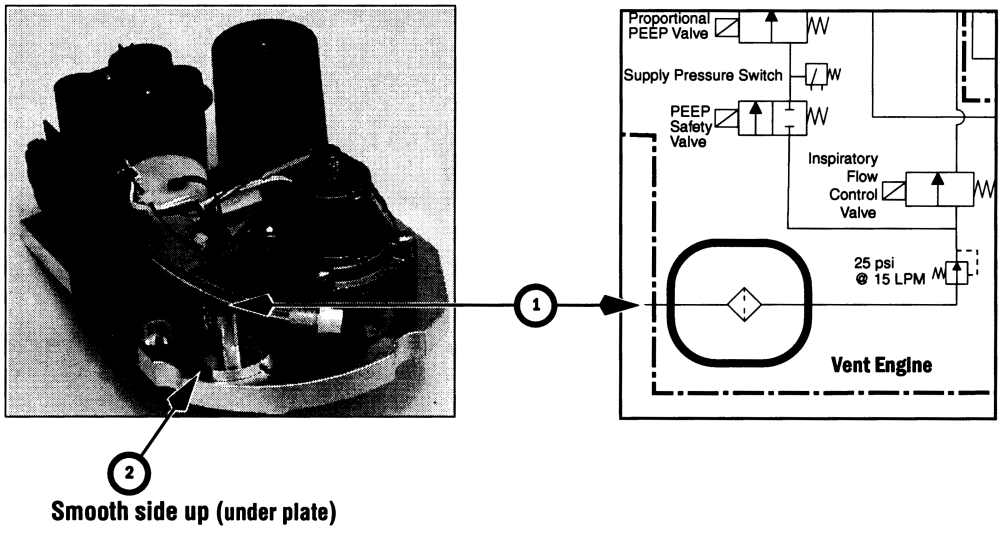


Figure 2-28 • Inlet filter

2.8.2 Pressure Regulator

The pressure regulator (**3**) is a non-relieving pressure regulator that regulates high pressure filtered supply gas down to 172 kPa (25 psi).

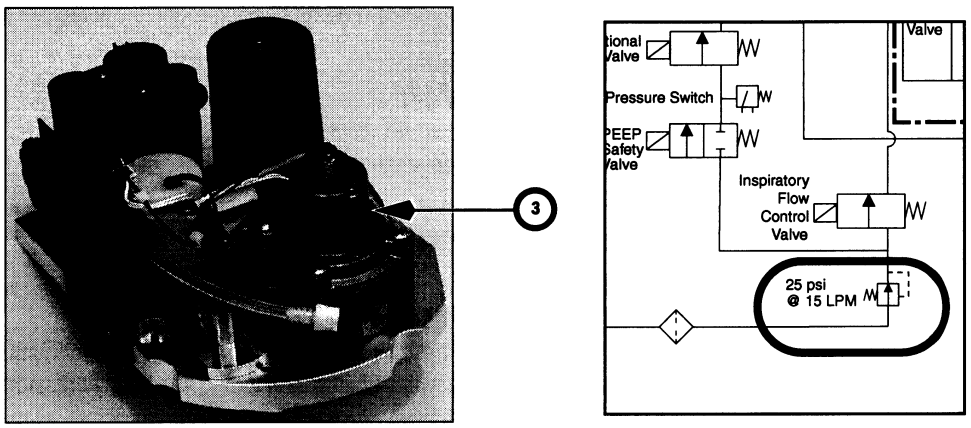


Figure 2-29 • Pressure regulator

2.8.3 Inspiratory flow control valve

The inspiratory flow control valve (**4**) is cycled by the control board to supply drive gas to the outer chamber of the bellows assembly at a rate determined by ventilator settings and sensor signals. The control valve modulates the incoming 172 kPa (25 psi) drive gases to an output from 0 to 70 liters per minute at pressures ranging from 0 to 100 cm H_2O.

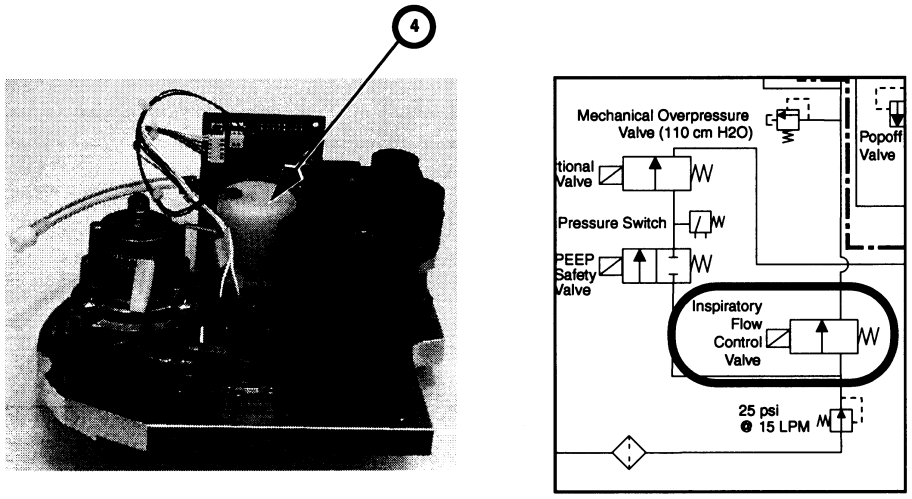


Figure 2-30 • Flow control valve

2.8.4 Exhalation (PEEP) Control

The exhalation valve contains an elastomeric diaphragm that is used to control the pressures in the breathing circuit. The exhalation valve includes two male ports on the bottom for:

- Bellows drive gas (**5**)
- Exhalation valve pilot (**6**) - (manifold pressure)

The exhalation valve includes three ports on top that connect to the bellows base manifold:

- Drive gas pass through (**7**)
- Drive gas return and pop-off valve flow (**8**)
- APL exhaust flow to scavenging (**9**)

A port at the back of the exhalation valve (**10**) connects to the down tube that directs all the exhaust flows to the scavenging receiver.

The exhalation valve is normally open. When the exhalation port is open, gas flows from the bellows housing to the scavenging port. Approximately 2 cm H_2O of pilot pressure is necessary to close the valve. Pilot control of the exhalation valve is done with PEEP Control Valve (**A**), Supply Pressure Switch (**B**), and the PEEP Safety Valve (**C**).

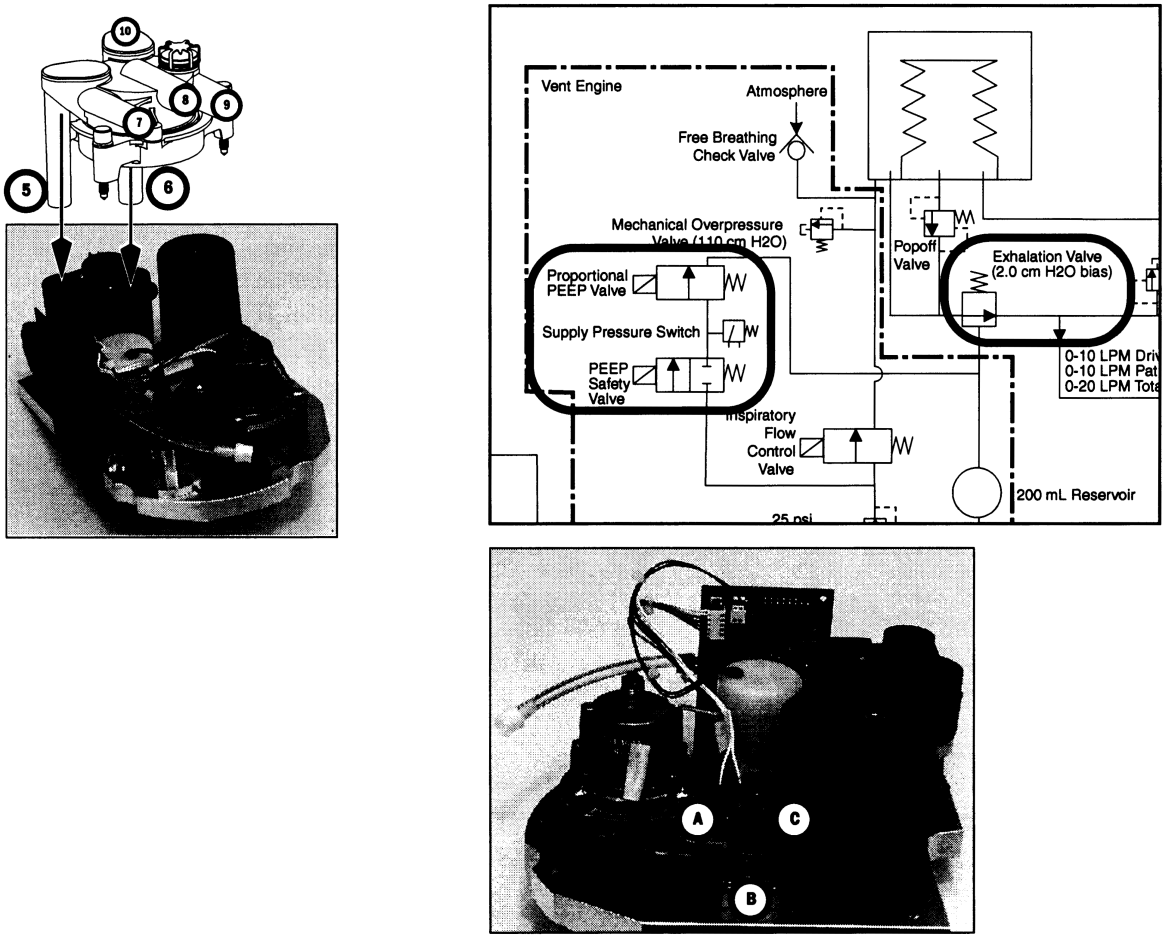


Figure 2-31 • Exhalation (PEEP) valve

2.8.5 Reservoir and bleed resistor

The reservoir (**11**) is a 200 ml chamber that dampens the manifold (pilot) pressure pulses to the exhalation valve.

The bleed resistor (**12**) is a "controlled leak" from 0 to 10 L/min in response to circuit pressures from 0 to 100 cm H_2O. The small quantity of pneumatic flow exhausting through the bleed resistor permits control of the exhalation valve's pilot pressure by modulation of the valve output. The bleed resistor exhausts only clean drive gas and must not be connected to a waste gas scavenging circuit. The output is routed away from the electrical components to make sure that systems using oxygen drive gas meet the 10VA limitation requirement for oxygen enrichment.

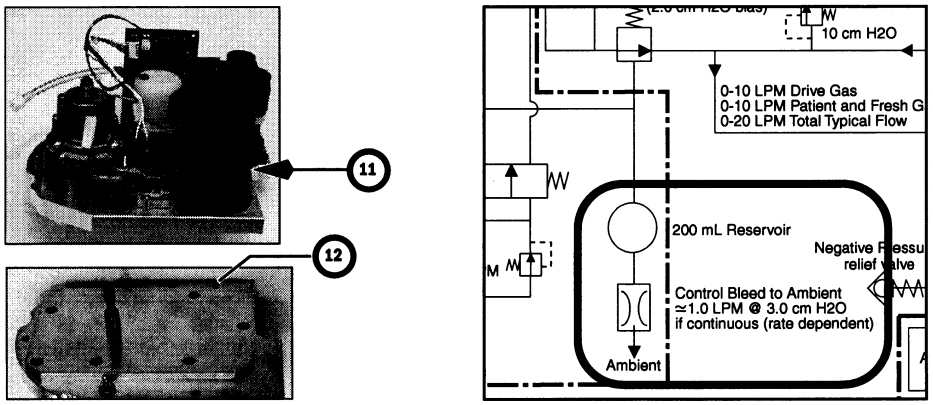


Figure 2-32 • Reservoir and bleed resistor

2.8.6 Bellows Pressure Relief Valve

The Bellows assembly is the interface between drive gas and the patient circuit in the breathing system. The pressure relief valve (or pop-off valve) in the bellows assembly (**13**) limits pressure in the patient circuit. Excess fresh gas is discharged through the exhalation valve into the gas scavenging system.

The pressure relief valve is normally closed, maintaining approximately 1.5 cm H_2O in the breathing circuit in a no flow condition, enough to keep the bellows inflated. It is piloted closed during inspiration and remains closed until the bellows is refilled during exhalation. If the pressure in the patient circuit exceeds 4 cm H_2O, the pop-off valve opens to exhaust excess fresh gas flow at a rate up to 4 L/min.

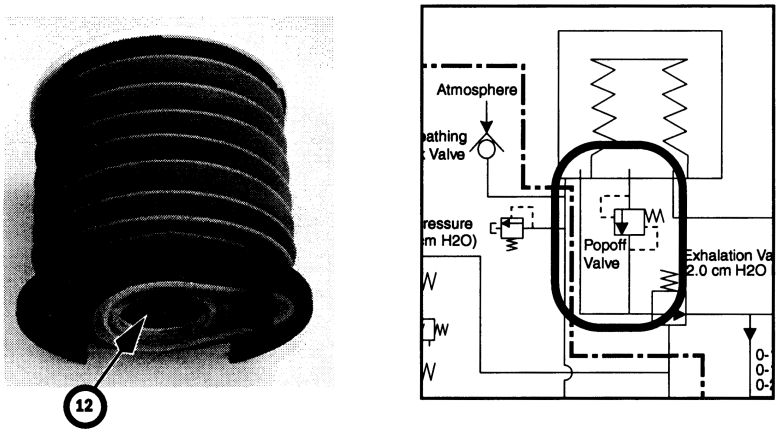


Figure 2-33 • Bellows pressure relief valve

2.8.7 Mechanical Overpressure Valve

The Mechanical Overpressure Valve (MOPV) is a mechanical valve (**14**) that operates regardless of electrical power. It functions as a third level of redundancy to the ventilator's pressure limit control functions, supplying pressure relief at approximately 110 cm H_2O.

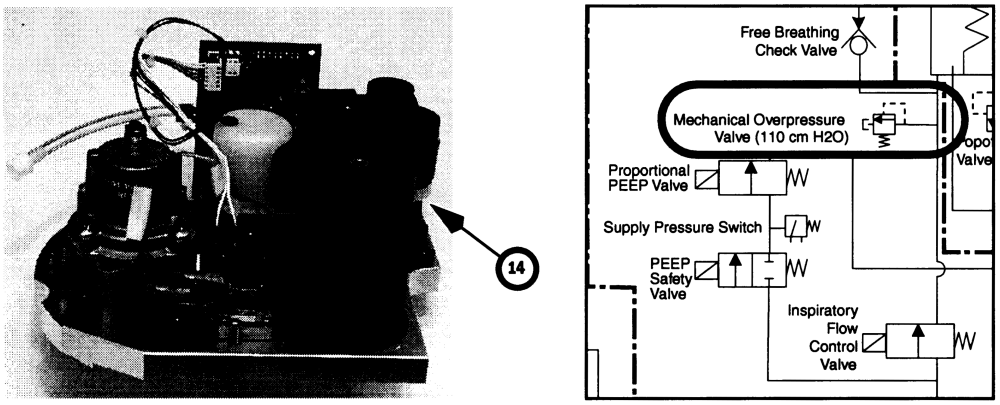


Figure 2-34 • Mechanical overpressure valve

2.8.8 Free Breathing Valve

The free breathing valve (**15**) helps assure the patient can spontaneously breathe. The ventilator is programmed to supply a specified number of breaths per minute to the patient. If, in between one of these programmed cycles, the patient needs a breath (spontaneous), the free breathing valve permits the patient to inhale. The free breathing valve is closed on mechanical inspiration.

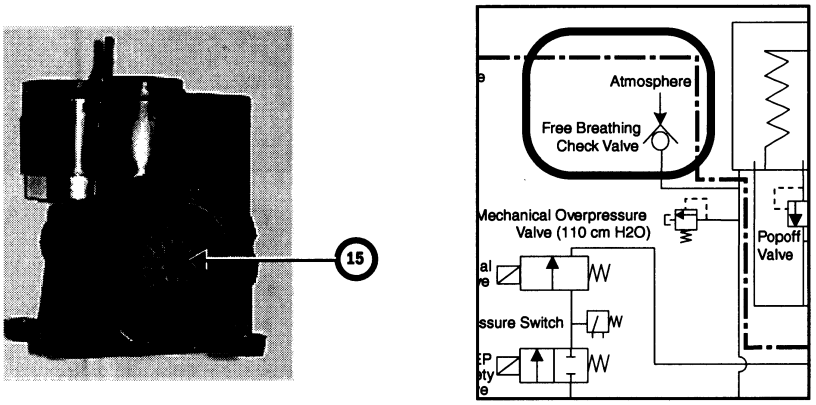


Figure 2-35 • Free breathing valve

2.8.9 Breathing Circuit Flow Sensors

Two flow sensors are used to monitor inspiratory and expiratory gas flow. The inspiratory flow sensor is downstream of the gas system inspiratory check valve. Feedback from the inspiratory transducer is used to supply tidal volumes that make allowances for the effects of fresh gas flow and circuit compressibility. The expiratory flow sensor is located at the input to the gas system expiratory check valve. Feedback from the expiratory flow sensor is used to supply signals for expiratory tidal volume monitoring and the breath rate.

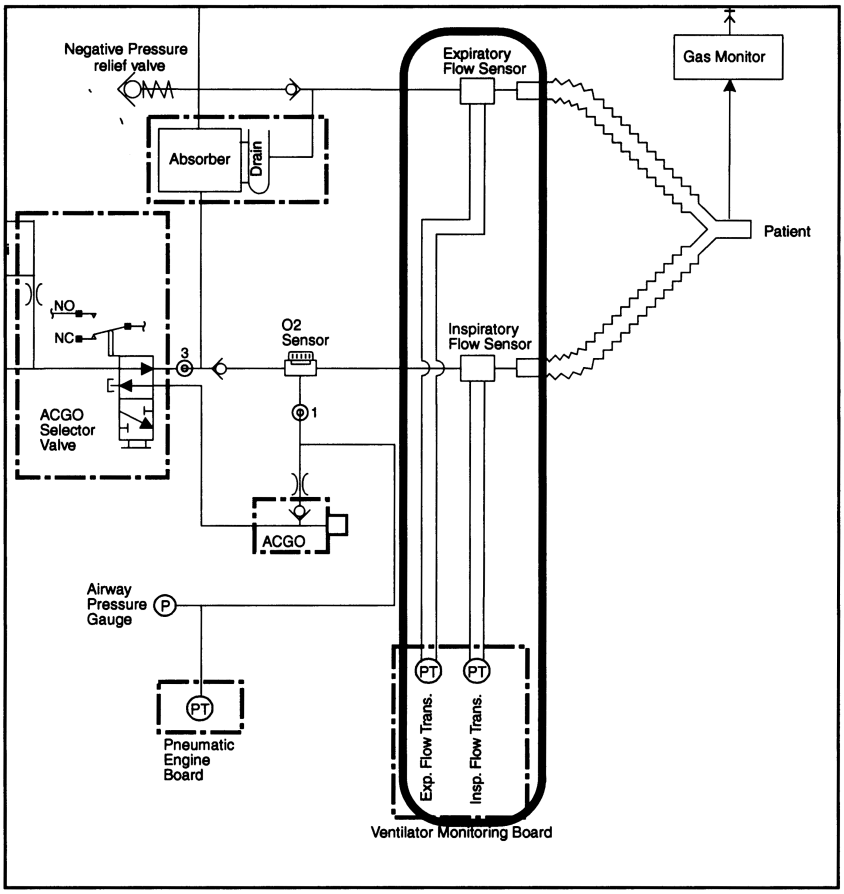


Figure 2-36 • Flow sensors

3 Checkout Procedure

In this section

3.1 Ventilator post-service checkout 3-2
3.2 Inspect the system 3-2
3.3 Pipeline and cylinder tests 3-3
3.4 Flow control tests 3-4
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3.13 Integrated Suction Regulator tests 3-18
3.14 Power failure test 3-19
3.15 Electrical safety tests 3-19

⚠ WARNINGS

After any repair or service of the Aespire system, complete all tests in this section.

Before you do the tests in this section:

- Complete all necessary calibrations and subassembly tests. Refer to the individual procedures for a list of necessary calibrations.
- Completely reassemble the system.

If a test failure occurs, make appropriate repairs and test for correct operation.

3.1 Ventilator post-service checkout

After servicing the 7100 ventilator, perform the following service mode Calibrations:

- O_2 Calibration
- Zero Flow and Airway Sensors
- Adjust Drive Gas Regulator
- Airway Sensor Span
- PEEP Valve Calibration
- Inspiratory Valve Calibration
- Pressure Sensitivity

Then, complete the checkout procedure for the entire machine in the following sections.

3.2 Inspect the system

⚠ CAUTION The upper shelf weight limit is 34 kg (75 lb).

⚠ WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

Before testing the system, ensure that:

- The equipment is not damaged.
- Components are correctly attached.
- The breathing circuit is correctly connected, not damaged.
- Pipeline gas supplies are connected.
- Cylinder valves are closed.
- Models with cylinder supplies have a cylinder wrench attached to the system.
- Models with cylinder supplies have a reserve supply of O_2 connected to the machine during system checkout.
- The casters are not loose and the brakes are set and prevent movement.
- The power cord is connected to a wall outlet. The mains indicator comes on when AC Power is connected.

3.3 Pipeline and cylinder tests

⚠ CAUTION To prevent damage:

- Open the cylinder valves slowly.
- Do not force the flow controls.

If your system does not use cylinder supplies, do not do steps 2 and 3.

1. Disconnect the pipeline supplies and close all cylinder valves (if equipped). If the pipeline and the cylinder pressure gauges are not at zero, bleed all gasses from the system.
   a. Connect an O_2 supply.
   b. Set the system switch to On.
   c. Set the flow controls to mid range.
   d. Make sure that all gauges but O_2 are at zero.
   e. Disconnect the O_2 supply.
   f. Make sure that the O_2 gauge goes to zero. As pressure decreases, alarms for low O_2 supply pressure should occur.
2. Make sure that the cylinders are full:
   a. Open each cylinder valve.
   b. Make sure that each cylinder has sufficient pressure. If not, close the applicable cylinder valve and install a full cylinder.
3. Test one cylinder at a time for high pressure leaks:
   a. Set the system switch to Standby, which stops the O_2 flow.
   b. If equipped, turn the auxiliary O_2 flow control fully clockwise (no flow).
   c. If equipped, turn off venturi derived suction.
   d. Open the cylinder.
   e. Record the cylinder pressure.
   f. Close the cylinder valve.
   g. Record the cylinder pressure after one minute. If the pressure decreases more than indicated below, there is a leak.
      5000 kPa (725 psig) for ventilator drive gas.
      690 kPa (100 psig) for non ventilator drive gas.
      Install a new cylinder gasket and do this step again.
   h. Repeat step 3 for all cylinders.

⚠ WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

4. Connect the pipeline supplies one at a time and ensure that the corresponding gauge indicates pipeline pressure.

3.4 Flow control tests

If the system includes O_2 monitoring, complete the flow control tests in Section 3.4.1, "With O_2 monitoring".

If the system does not include O_2 monitoring, complete the flow control tests in Section 3.4.2, "Without O_2 monitoring".

3.4.1 With O_2 monitoring

⚠ WARNING Nitrous oxide (N_2O) flows through the system during this test. Use a safe and approved procedure to collect and remove it.

1. Set up the gas scavenging system.
   a. Connect the AGSS to a gas scavenging system.
   b. Attach a patient circuit and plug the patient port.
   c. Attach a bag to the bag port (or plug the bag port).
   d. Set the Bag/Vent switch to Bag.
   e. Adjust the APL valve to minimum.
2. Connect the pipeline supplies or slowly open the cylinder valves.
3. Turn all flow controls fully clockwise (minimum flow).
4. Set the ACGO selector switch to ABS.
5. Turn on the system.
6. Confirm that the O_2 sensor measures 21% in room air and 100% in pure O_2. If not, calibrate the O_2 sensor.
7. Make sure that:
   - For a dual-tube O_2 flowmeter, the O_2 flowtube shows 0.025 to 0.075 L/min.
   - For a single-tube O_2 flowmeter, the O_2 flowtube shows 0.175 to 0.225 L/min.
   - The other flowtubes show no gas flow.
8. Set the flow controls to mid range of each flowtube and make sure that the flowtube floats rotate and move smoothly.

Note If the system does not include N_2O, skip steps 9 and 10.

9. Check the Link proportioning system concentration (increasing N_2O flow). Observe the following precautions:
   a. Start with all valves at the minimum setting.
   b. Adjust only the N_2O flow control.
   c. Increase the N_2O flow as specified in the following table and make sure the O_2 concentration is in range.

Note: Allow the O_2 monitor to stabilize. At the lower flows, the O_2 monitor may take up to 90 seconds to stabilize.

d. If you overshoot a setting, turn the O_2 flow control clockwise until the N_2O flow decreases to the previous setting before continuing the test.

Set the N_2O flow (L/min)	Measured O_2
0.15 (dual flowtubes only)	21% minimum
0.5 (dual flowtubes only)	21% minimum
0.8	21% to 30%
1.0	21% to 30%
2.0	21% to 30%
6.0	21% to 30%
9.0	21% to 30%

10. Check the proportioning system concentration (decreasing O_2 flow). Observe the following precautions:

a. Start with N_2O valve at the maximum setting.

b. Adjust only the O_2 flow control.

c. Decrease the O_2 flow as specified in the table and make sure the O_2 concentration is in the allowed range.

Note: Allow the O_2 monitor to stabilize. At the lower flows, the O_2 monitor may take up to 90 seconds to stabilize.

d. If you overshoot a setting, turn the N_2O flow control counterclockwise until the O_2 flow increases to the previous setting before continuing the test.

Set the O_2 flow (L/min)	Measured O_2
3.0	21% to 30%
2.0	21% to 30%
1.0	21% to 30%
0.3	21% to 30%

11. Check the linearity of the Air flow control.

- Turn the N_2O flow control fully clockwise to minimum stop.

Set the O_2 flow (L/min)	Set the Air flow (L/min)	O_2 monitor range
4.0	3.0	61% to 71%
3.5	6.0	45% to 55%
1.5	8.0	28% to 38%

3.4.2 Without O_2 monitoring

⚠ WARNING The following procedure will test for any significant malfunction of the Link system but it will not confirm proper calibration. Periodic calibration procedures using an accurate and properly calibrated O_2 monitor must be performed as recommended in the User's Reference Manual, Part 2, section 3 User Maintenance.

⚠ Nitrous oxide (N_2O) flows through the system during this test. Use a safe and approved procedure to collect and remove it.

1. Set up the gas scavenging system.
   a. Connect the AGSS to a gas scavenging system.
   b. Attach a patient circuit and plug the patient port.
   c. Attach a bag to the bag port (or plug the bag port).
   d. Set the Bag/Vent switch to Bag.
   e. Adjust the APL valve to minimum.
2. Connect the pipeline supplies or slowly open the cylinder valves.
3. Turn all flow controls fully clockwise (minimum flow).
4. Set the ACGO selector switch to ABS.
5. Turn on the system.
6. Make sure that:
   - For a dual-tube O_2 flowmeter, the O_2 flowtube shows 0.025 to 0.075 L/min.
   - For a single-tube O_2 flowmeter, the O_2 flowtube shows 0.175 to 0.225 L/min.
   - The other flowtubes show no gas flow.
7. Set the flow controls to mid range of each flowtube and make sure that the flowtube floats rotate and move smoothly.

Note If the system does not include N_2O, skip steps 8 and 9.

8. Check the Link proportioning system (increasing N_2O flow). Observe the following precautions:
   a. Start with all valves at the minimum setting.
   b. Adjust only the N_2O flow control.
   c. Increase the N_2O flow as specified in the following table and make sure the O_2 flow is as specified.

d. If you overshoot a setting, turn the O_2 flow control clockwise until the N_2O flow decreases to the previous setting before continuing the test.

Set the N_2O flow control to (L/min)	The O_2 flow must be greater than (L/min):
0.8	0.2
2	0.5
4	1.0
10	2.5

9. Check the Link proportioning system (decreasing O_2 flow). Observe the following precautions:

   a. Set the N_2O flow to 9.0 L/min.

   b. Set the O_2 flow to 3 L/min or higher.

   c. While reducing the O_2 flow, set the N_2O flow to the rates shown in the table. The O_2 flow must be greater than the minimum limits.

   d. If you overshoot a setting, turn the N_2O flow control counterclockwise until the N_2O flow increases to the previous setting before continuing the test.

Set the N_2O flow (using the O_2 flow control) to (L/min)	The O_2 flow must be greater than (L/min)
8.0	2.0
4.0	1.0
0.8	0.2

3.5 Pressure relief tests

To check the pressure relief valve (vaporizer manifold outlet).

1. Turn all flow controls fully clockwise (minimum flow).
2. Set the ACGO selector switch to ACGO.
3. Connect a gauge or a digital manometer to the ACGO outlet using the positive pressure leak test adapter.
4. Adjust the O_2 flow to 0.5 L/min.
5. Verify that the test device reading stabilizes within the following range:
   31–60 kPa, 230–450 mm Hg, 4.5–8.5 psi.
6. Remove the test device and the adapter.

Test Adapter

3.6 O_2 supply alarm test

1. Set all flow controls to 3 L/min.
2. Stop the O_2 supply. (Disconnect the pipeline supply or close the cylinder valve.)
3. Make sure that:
   a. The low O_2 supply alarm occurs.
   b. The N_2O (if equipped) and O_2 flows stop. The O_2 flow stops last.
   c. Air (if equipped) flow continues.
   d. Gas supply alarms occur on the ventilator if the ventilator uses O_2 as the drive gas.
4. Turn all of the flow controls fully clockwise (minimum flow).
5. Reconnect the pipeline supplies.

3.7 Flush Flow Test

With Ventilator

1. Set the Bag/Vent switch to Vent.
2. Set the system switch to Standby.
3. Attach a patient circuit and plug the patient port.
4. Set the ACGO selector switch to ABS (Circle).
5. Ensure that the bellows is completely collapsed.
6. Measure the amount of time it takes to fill the bellows when the O_2 Flush button is fully and continuously depressed.
7. Repeat the above measurement two more times (deflate bellows by removing the plug from the patient port).
   - The bellows should fill in 1.8 to 2.3 seconds.

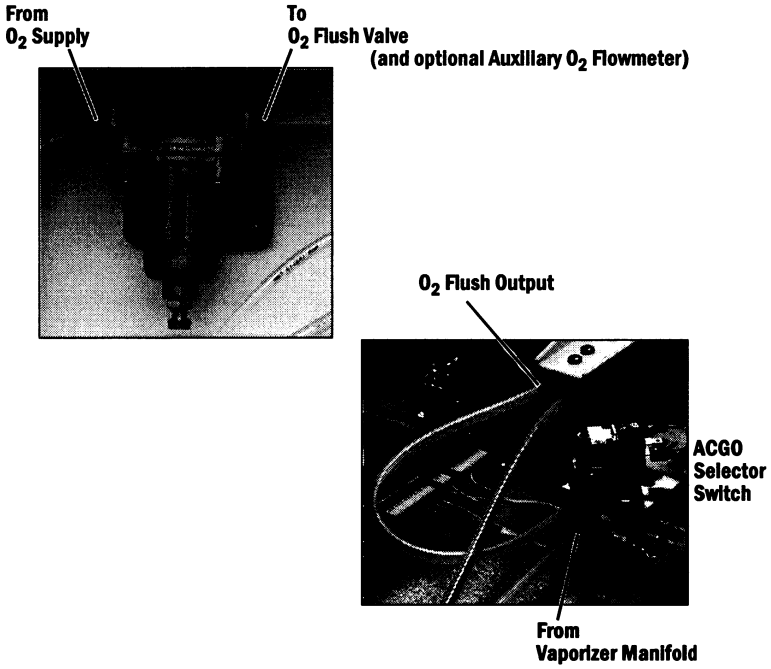
Without Ventilator:

1. Set the Bag/Vent switch to Bag.
2. Set the system switch to Standby.
3. Attach a patient circuit and plug the patient port.
4. Attach a 3-liter rebreathing bag on the bag arm or manual bag port (if a 3-liter bag is not available, use the time specified for a 1-liter bag times the volume of the bag used).
5. Set the ACGO selector switch to ABS (Circle).
6. Ensure that the rebreathing bag is completely collapsed.
7. Adjust the APL valve to maximum.
8. Measure the amount of time it takes to fill the rebreathing bag when the O_2 Flush button is fully and continuously depressed.

   Note: When the airway pressure gauge exceeds 10 cm H_2O, the rebreathing bag is full.
9. Repeat the above step two more times (deflate the rebreathing bag by removing the plug from the patient port).
   - A 3-liter bag should fill in 3.6 to 5.1 seconds.
   - A 1-liter bag should fill in 1.2 to 1.7 seconds.

Possible Causes of Failure

- Large leak (if long filling time).
- Flush regulator setting (Section 5.5).
- Flush regulator cross-connection (if long filling time).
- ACGO selector valve inlet cross-connection (if short filling time).



3.8 Vaporizer back pressure test

⚠ **WARNING** Anesthetic agent vapor comes out of the common gas outlet during this test. Use a safe, approved procedure to remove and collect the agent.

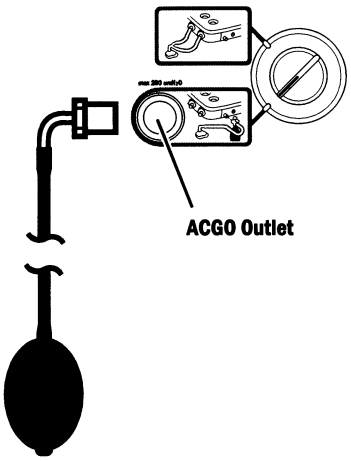
1. Set up the gas scavenging system.
   a. Connect the AGSS to a gas scavenging system.
   b. Attach a patient circuit and plug the patient port.
   c. Attach a bag to the bag port (or plug the bag port).
   d. Set the Bag/Vent switch to Bag.
   e. Adjust the APL valve to minimum.
2. Set the ACGO selector switch to ABS.
3. Set the system switch to On.
4. Set the O_2 flow to 6 L/min.
5. Make sure that the O_2 flow stays constant and the float moves freely.
6. Adjust the vaporizer concentration from 0 to 1% one click at a time. The O_2 flow must not decrease more than 1 L/min through the full range. If the O_2 flow decreases more than 1 L/min:
   a. Install a different vaporizer and try this step again.
   b. If the O_2 flow decreases less than 1 L/min with a different vaporizer, the malfunction is in the first vaporizer.
   c. If the O_2 flow also decreases more than 1 L/min with a different vaporizer, the malfunction is in the Aespire system. Do not use the system until it is serviced (repair vaporizer manifold port valve).
7. Complete steps 3 through 5 for each vaporizer and vaporizer position.
8. Set the system switch to Standby.

3.9 Low-pressure leak test

Note Perform either the "Negative low-pressure leak test" or the "ISO or BSI standard low-pressure leak test. It is not necessary to perform both tests.

⚠ WARNING Do not use a system with a low-pressure leak. Anesthetic gas will go into the atmosphere, not into the breathing circuit.

3.9.1 Negative low-pressure leak test



1. Test the leak test device:
   a. Put your hand on the inlet of the leak test device. Push hard for a good seal.
   b. Squeeze the bulb to remove all air from the bulb.
   c. If the bulb completely inflates in less than 60 seconds, replace the leak test device.
2. Set the system switch to Standby.
3. Set the ACGO selector switch to ACGO.
4. Turn off all vaporizers.
5. Test the anesthesia machine for low-pressure leaks:
   a. Open the flow controls one and a half turns counterclockwise.
   b. Connect the test device to the ACGO outlet.
   c. Compress and release the bulb until it is empty.
   d. The vacuum causes the floats to move. This is usual. If the bulb completely inflates in 30 seconds or less, there is a leak in the low-pressure circuit.
6. Test each vaporizer for low-pressure leaks:
   a. Set the vaporizer to 1%.
   b. Repeat step 5.
   c. Set the vaporizer to OFF.
   d. Test the remaining vaporizers.
7. Disconnect the test device.
8. Turn all flow controls fully clockwise (minimum flow). Do not over tighten.

⚠ WARNING Agent mixtures from the low-pressure leak test stay in the system. Always flush the system with O_2 after the low-pressure leak test (1 L/min for one minute).

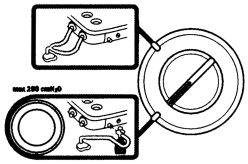
Turn off all vaporizers at the end of the low-pressure leak test.

9. Flush the system with O_2:
   a. Set the system switch to On.
   b. Set the O_2 flow to 1 L/min.
   c. Continue the O_2 flow for one minute.
   d. Turn the O_2 flow control fully clockwise (minimum flow).
   e. Set the system switch to Standby.

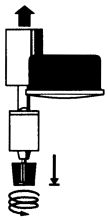
3.9.2 ISO or BSI standard low-pressure leak test

⚠ CAUTION Do the positive pressure leak test at the ACGO outlet only.

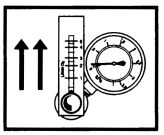
1. Set the ACGO selector switch to ACGO.
2. Turn all flow controls fully clockwise (minimum flow).
3. Using the positive pressure leak test adapter, connect the ISO or BSI specific leak test device to the ACGO outlet. Push the adapter into the ACGO outlet throughout the test to get a good seal.



Leak Test Adapter



Test Device (Top View)



Test Device (Front View)

4. Keep flowmeter of the test device vertical for accurate results.
5. Fully open the needle valve on the test device (counterclockwise).

⚠ CAUTION If the needle valve is not fully open, this test can damage the pressure gauge on the test device.

6. Set the system switch to On.

7. Open the O_2 flow control and set a total flow of 0.4 L/min through the flowmeter on the test device.
8. Make sure that the pressure gauge on the test device reads zero and that all other flow controls are fully closed.
9. Close the needle valve on the test device until the test gauge reads:

ISO 5358	**3 kPa**
BSI 4272.3	**20 kPa**

10. If the flow through the test device is less than
0.35 L/min (ISO) or
0.3 L/min (BSI),
there is a low pressure leak in the anesthesia machine.
11. Fully open the needle valve on the test device to decrease the back pressure.
12. Test each vaporizer for low-pressure leaks:
    a. Set the vaporizer to 1%.
    b. Repeat steps 7 through 10.
    c. Turn the vaporizer OFF.
    d. Test the remaining vaporizers.
13. Remove test tool and adapter.

⚠ WARNING Agent mixtures from the low-pressure leak test stay in the system. Always flush the system with O_2 after the low-pressure leak test (1 L/min for one minute).

Turn all vaporizers OFF at the end of the low-pressure leak test.

14. Flush the system with O_2:
    a. Set the system switch to On.
    b. Set the O_2 flow to 1 L/min.
    c. Continue the O_2 flow for one minute.
    d. Turn the O_2 flow control fully clockwise (minimum flow).
    e. Set the system switch to Standby.

3.10 Alarm tests

1. Connect a test lung to the patient connection.
2. Set the Bag/Vent switch to Vent.
3. Set the system switch to On.
4. Set the controls:
   - Ventilation Mode: Volume control (select from main menu)
   - Ventilator:
     - Tidal Vol: 400 ml
     - Rate: 12
     - I:E Ratio:1:2
     - Plimit:40 cm H_2O
     - PEEP: OFF
   - Anesthesia Machine:
     - O_2 flow: minimum flow
     - All other gases: OFF
     - ACGO selector switch to ABS
5. Push O_2 Flush to fill the bellows.
6. Set the Bag/Vent switch to Bag and back to Vent.
7. Make sure that:
   a. Mechanical ventilation starts.
   b. A subatmospheric pressure alarm does not occur.

      Note: With active gas scavenging, too much scavenging flow can cause subatmospheric alarm.
   c. The ventilator displays the correct data.
   d. The bellows inflate and deflate during mechanical ventilation.
8. Set the O_2 flow control to 5 L/min.
9. Make sure that:
   a. The end expiratory pressure is approximately 0 cm H_2O.

      Note: Positive end expiratory pressure when PEEP is off may indicate that the scavenging system is not removing enough gas.
   b. The ventilator displays the correct data.
   c. The bellows inflate and deflate during mechanical ventilation.
10. Test the low minute volume alarm:
    a. Go to the alarms menu.
    b. Set the alarm limit for low minute volume to 6.0 L/min.
    c. Make sure that a low minute volume alarm occurs.
    d. Go to the alarms menu.
    e. Set the low minute volume alarm to OFF.

11. Test the high airway pressure alarm:
    a. Set P_{limit} to less than the peak airway pressure.
    b. Make sure that the high airway pressure alarm occurs.
    c. Set P_{limit} to correct level.
12. Test the apnea and low airway pressure alarms:
    a. Turn all flow controls fully clockwise.
    b. Remove the test lung from the patient connection.
    c. Other alarms such as low minute volume can occur.
    d. Make sure that the low airway pressure and apnea alarms occur. The apnea alarm occurs after 30 seconds.
13. Test the sustained airway pressure alarm:
    a. Set the controls:
       - APL valve – Closed (70)
       - Bag/Vent switch – Bag
    b. Mechanical ventilation stops when the Bag/Vent switch is set to Bag.
    c. Occlude the bag port connector with a test plug.
    d. Close the patient connection using the test plug located on the side of the ABS and push the O_2 Flush button.
    e. Make sure that the sustained pressure alarm occurs after approximately 15 seconds at the sustained pressure limit (6-30 cm H_2O varies with pressure limit).
14. Test the O_2 monitor and alarms:
    a. Remove the O_2 sensor from the circuit module.
    b. Make sure the sensor measures approximately 21% O_2 in room air.
    c. Set the low O_2 alarm to 50%. Make sure a low O_2 alarm occurs.
    d. Set the low O_2 alarm back to 21% and make sure that alarm cancels.
    e. Put the O_2 sensor back in the circuit.
    f. Remove the test lung from the patient connection.
    g. Set the High O_2 alarm to 50%.
    h. Push the flush button to fill the breathing system.
    i. Set the O_2 flow control to 2 L/min.
    j. Make sure the high O_2 alarm comes On.
    k. Set the high O_2 alarm back to 100% and make sure that alarm cancels.
    l. After 2 minutes in pure O_2, the O_2 display reads approximately 100%.
    m. Turn the O_2 flow control fully clockwise (minimum flow).
15. Set the system switch to Standby.

3.11 Breathing system tests

⚠ WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.

1. Verify that AGSS is operating. For systems that have a flow indicator on the side, make sure that the flow indicator shows a flow in the green (normal) region.
2. Zero the pressure gauge (Section 5.6.1).

Check Valves

3. Make sure that the check valves on the breathing circuit module work correctly:
   a. The Inspiratory check valve rises during inspiration and falls at the start of expiration.
   b. The Expiratory check valve rises during expiration and falls at the start of inspiration.

Ventilator Bellows

4. Ventilator bellows test:
   a. Set the system switch to Standby.
   b. Set the Bag/Vent switch to Ventilator.
   c. Set all flow controls to minimum.
   d. Close the breathing circuit at the patient connection. Use the test plug located on the side of the ABS.
   e. Push the O_2 flush button to fill the bellows.
   f. The pressure must not increase to more than 15 cm H_2O on the pressure gauge.
   g. If the bellows falls more than 100 mL/min (top of indicator), it has a leak.

Service Mode Tests

5. Enter the Service Mode: Push and hold the adjustment knob on the ventilator's display and set the system switch to On.
   a. Select and confirm "Service Modes."
   b. Follow the menu structure outline below to reach the adjustment for the inspiratory flow valve. Select and confirm at each step.
      - "Diagnostics Tests/Tools"
      - "Breathing System Leak Test"
   c. Follow the instructions on the screen.
   d. The leak rate should be less than 200 mL/min.
      For machines with a single-tube O_2 flowmeter, the pressure reading should reach 30 cm H_2O at minimum flows greater than 200 mL/min.

Note: If test fails, see Section 7.2, "Breathing System Leak Test Guide".

Bag Circuit

6. Test the Bag circuit for leaks:
   a. Set the system switch to On.
   b. Set the Bag/Ventilator switch to Bag.
   c. Plug the Bag port (use your hand or the approved test plug).
   d. Close the APL valve (70 cm H_2O).
   e. Set the O_2 flow to 0.25 L/min.
   f. Close the patient connection (using a hand or test plug on the side of the breathing system) and pressurize the bag circuit with the O_2 flush button to approximately 30 cm H_2O.
   g. Release the flush button. The pressure must not decrease. A pressure decrease large enough to see on the gauge indicates an unacceptable leak.

Note: If test fails, see Section 7.2, "Breathing System Leak Test Guide".

APL Valve

7. Test the APL valve:
   a. Fully close the APL valve (70 cm H_2O).
   b. Set the total fresh gas flow to approximately 3 L/min and make sure that the value on the inspiratory pressure gauge does not exceed 85 cm H_2O. Some pressure fluctuation is normal.
   c. Fully open the APL valve (to the MIN position).
   d. Set O_2 flow to 3 L/min. Turn any other gases off.
   e. Make sure that the value on the inspiratory pressure gauge is less than approximately 5 cm H_2O.
   f. Push the O_2 flush button. Make sure that the value on the inspiratory pressure gauge stays less than 10 cm H_2O.
   g. Set the O_2 flow to minimum and make sure that the value on the inspiratory pressure gauge does not decrease below 0 cm H_2O.
8. Remove your hand or the test plug from the patient connection.
9. Set the System switch to Standby.

⚠ WARNING Make sure that there are no test plugs or other objects caught in the breathing system.

3.12 Auxiliary O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Occlude the auxiliary O_2 outlet. The ball should rest at the bottom of the flow tube and not move. A ball that does not rest at the bottom of the flow tube indicates a leak and requires service.
5. Rotate the flow control clockwise to shut off the flow.

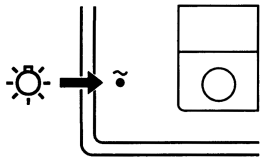
3.13 Integrated Suction Regulator tests

The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of calibration.

1. Adjust the regulator setting to minimum.
2. Turn the mode selector to I (On).
3. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
4. Occlude the inlet.
5. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
6. Adjust the regulator in an increasing vacuum level.
7. The gauge should rise after rotation has begun. The gauge should rise with continued rotation of the regulator adjustment.
8. Adjust the regulator setting to minimum.
9. Turn the Mode selector to O (Off).

3.14 Power failure test

1. Connect the power cord to a mains outlet. The mains indicator on the display comes on when AC Power is connected.



If the indicator is not on, the display assembly is not receiving AC power.

- Verify AC power to the machine (reset circuit breaker).
- Check fuses in display assembly's inlet module.
- Check fuses in machine's AC inlet assembly.

2. Set the system switch to On.
3. Unplug the power cord with the system turned on.
4. Make sure that the power failure alarm comes on.
5. Make sure the following message is on the ventilator display:
   - "On Battery - Power OK?"
6. Connect the power cable again.
7. Make sure the alarm cancels.

3.15 Electrical safety tests

Make sure the system is completely assembled and all accessory devices are connected to electrical outlets.

1. Connect an approved test device (e.g. UL, CSA, or AAMI) and verify that the leakage current is less than:

Voltage	Max. Leakage Current
120/100 Vac	300 µAmps
220/240 Vac	500 µAmps

2. Make sure that the resistance to ground is less than 0.2Ω between an exposed metal surface and the ground pin on the power cord.

Notes

4 Self Tests and Service Mode

⚠ WARNING: Post-Service Checkout is required after you complete this section. You must perform *Section 3.1 Post-service checkout* after performing any maintenance, service or repair. Failure to do so may result in patient injury.

In this section

To ensure proper operation, the Aespire 7100 Ventilator includes several tests that run automatically (self tests) and a series of menu pages that a qualified service person can use to test, calibrate, or troubleshoot ventilator related components in the Aespire anesthesia machine (Service Mode).

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4.1 Self tests

The Aespire 7100 Ventilator software includes self tests that determine whether or not the operating software is functioning properly and whether or not the electronic circuits on the circuit boards are functional.

The self tests include:

- powerup tests
- continuous tests
- periodic tests

Powerup tests

The following list of the tests run at powerup:

- Sequential watchdog
- Logical watchdog
- Data RAM walking pattern test
- FLASH ROM CRC verification
- PEEP Valve test
- PEEP Safety Valve test

If one or more of these tests fail, the display provides a readout of the problem.

Continuous tests

These tests are run continuously during normal operation and alarms are associated with each test. A failure causes an alarm to display on the screen in the alarm display area.

- Supply voltage checks
- Battery voltage checks
- Inspiratory control valve DAC and voltage feedback
- PEEP control valve DAC and voltage feedback

Periodic tests

These tests are run every 30 seconds during normal operation. Alarms are associated with each test. A failure causes an alarm to display on the screen in the alarm display area.

- CPU Test
- Display RAM walking pattern test
- Data RAM walking pattern test
- FLASH ROM CRC verification

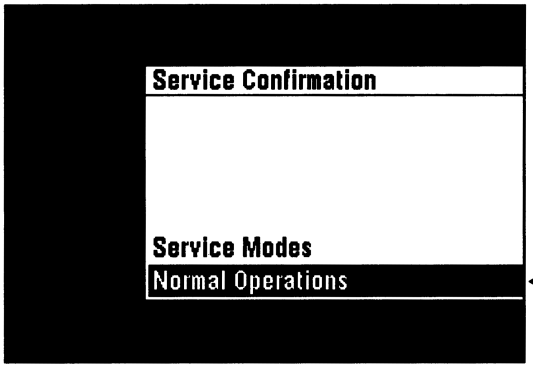
4.2 Service Mode

The ***Service Mode*** is used to test, calibrate, or troubleshoot ventilator related components in the anesthesia machine.

There are two ways to enter the service mode:

- If the machine is turned off, push and hold in the adjustment knob while setting the system switch to On. Hold the adjustment knob pushed in until the "Service Confirmation" menu appears. Use the adjustment knob to highlight "Service Mode", then push the adjustment knob to confirm the selection.
- If the machine is already in normal operation, set the Bag/Vent switch to Bag. Then, press the V_T/Pinsp, the PEEP, and the menu switches at the same time to reset the software (powerup). Push and hold the adjustment knob until the "Service Confirmation" menu appears.

  Note: Volume alarms must be in standby.

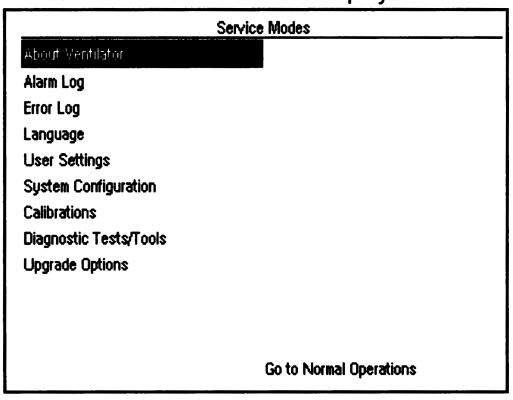


From this menu you can:

- Go to the Service Modes
- Return to Normal Operations

Service Modes Menu

The ***Service Modes*** main menu displays the service tests you can select.

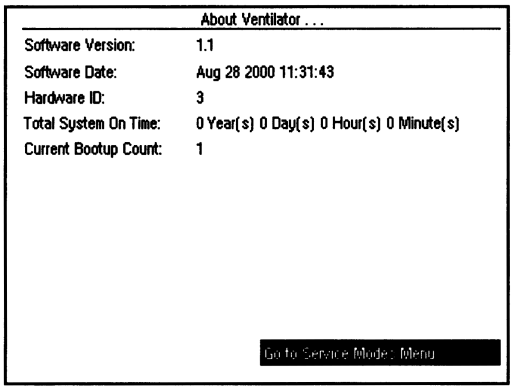


The selectable service tests are displayed in categorical order. But you can select the service test from this menu in any order. The following sections in this manual are sequenced in the order that they appear on the screen.

4.3 About Ventilator

The ***About Ventilator*** menu identifies the current software loaded into the ventilator's Flash-ROM memory and displays the total "on time" of the system.

- **Software Version**
- **Software Date**
- **Hardware ID**
- **Total System On Time**
- **Current Bootup Count** – The bootup count is incremented each time the machine is turned on. The bootup count is not overwritten when new software is loaded. However, if a new control board is installed, the bootup count will reflect the value stored in the EEPROM of the new board.



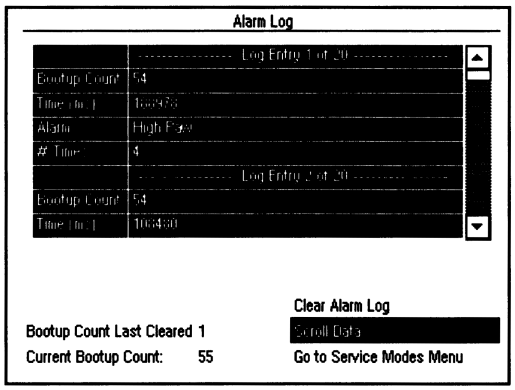
4.4 Alarm Log

The ***Alarm Log*** displays up to 20 of the most current alarm messages that have been logged. Each log entry shows:

- **Bootup Count** number (the bootup count is incremented each time the machine is turned on).
- **Time (ms)** – the time in milliseconds since bootup when the latest alarm condition occurred.
- **Alarm** message associated with the particular alarm condition.
- **# Times** – the number of times that the specific alarm condition has occurred during the noted bootup count.

The bottom-left corner of the screen displays additional information:

- **Bootup Count Last Cleared**
- **Current Bootup Count**



Scroll Data

To view all the log entries, select "Scroll Data."
Then, use the control knob to scroll through the entries.

To exit Scroll Data, press the control knob.

Clear Alarm Log

To clear the alarm log, select "Clear Alarm Log." The system asks you to confirm that you want to clear the alarm log.

Remarks

After you clear the alarm log:

- the "Bootup Count Last Cleared" number will be reset to the "Current Bootup Count" number.
- the menu will show the message "No entries in log!".

4.5 Error Log

There are two special types of alarms:

- Minimum monitoring alarms that stop mechanical ventilation
- Minimum shutdown alarms that stop mechanical ventilation and monitoring.

An alarm message that results from these special types of alarms is considered an error alarm.

The ***Error Log*** displays up to 20 of the most current Error messages that have been logged.

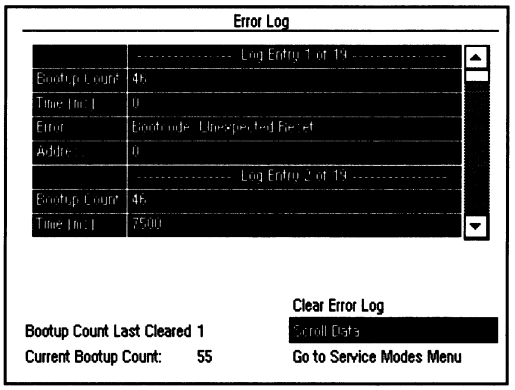
Each log entry shows:

- **Bootup Count** number (the bootup count is incremented each time the machine is turned on).
- **Time (ms)** – the time in milliseconds since bootup when the latest alarm condition occurred.
- **Error** message associated with the particular alarm condition.
- **Address** – the place in the software sequence where the last occurrence of the error took place.

The error address and software revision are important pieces of information to note if technical support is required.

The bottom-left corner of the screen displays additional information:

- **Bootup Count Last Cleared**
- **Current Bootup Count**



Scroll Data To view all the log entries, select "Scroll Data."
Then, use the control knob to scroll through the entries.
To exit Scroll Data, press the control knob.

Clear Error Log To clear the error log, select "Clear Error Log." The system asks you to confirm that you want to clear the error log.

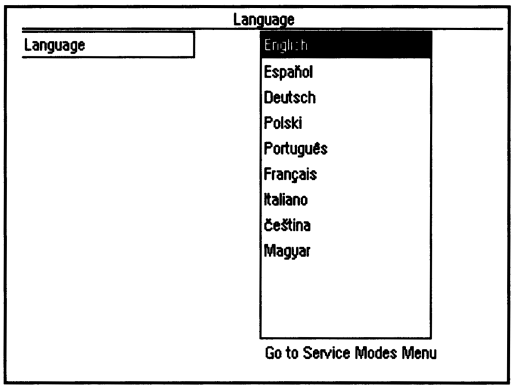
Remarks After you clear the alarm log:

- the "Boot Count Last Cleared" number will be reset to the "Current Boot Count" number.
- the menu will show the message "No entries in log!".

4.6 Language

The text shown in the normal mode of operation is language sensitive. However, the Service Confirmation menu (except for text "Normal Operation") and all the Service Modes menus are shown only in English.

The ***Language*** menu is used to set the specific language for normal operation.



The 7100 ventilator supports the following languages. The language selections appear in language specific text.

- . . . . . English
- Español . . . . . Spanish
- Deutsch . . . . . German
- Polski. . . . . Polish
- Português . . . . Portuguese
- Français . . . . . French
- Italiano. . . . . Italian
- Čeština . . . . . Czech
- Magyar . . . . . Hungarian
- Nederlands . . . Dutch
- . . . . . Greek
- . . . . . Russian
- . . . . . Japanese
- . . . . . Chinese

The following additional languages are available in Software revisions 1.4 and greater.

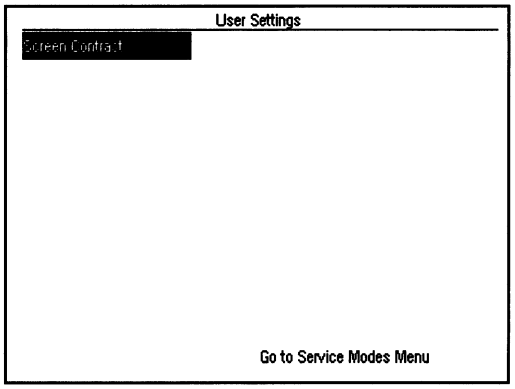
- Suomi . . . . . Finnish
- Türkçe . . . . . Turkish
- Norsk. . . . . Norwegian

The language setting is stored in EEPROM with the default setting as English.

4.7 User Settings

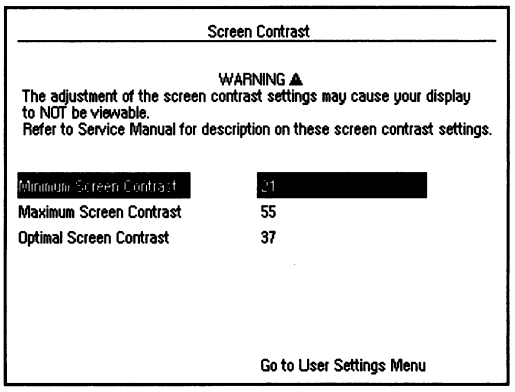
In normal operation, the user can set several parameters to a personal preference or to compensate for the surrounding influences. The range of some of these settings can vary from machine to machine.

The ***User Settings*** menu is used to adjust the range to normalized values.



4.7.1 Screen Contrast

The range from minimum to maximum screen contrast varies for individual displays. The ***Screen Contrast*** menu is used to tailor the range so that the screen image is still visible at minimum and maximum contrast settings for the user.



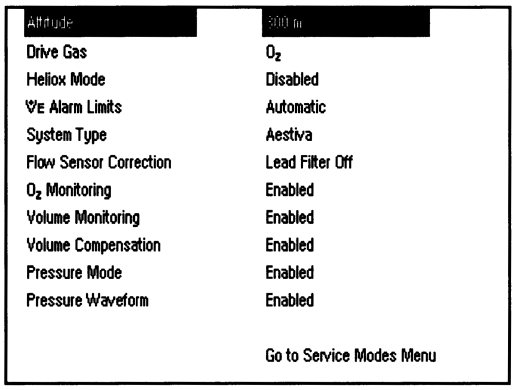
Remarks

The "Minimum Screen Contrast" and the "Maximum Screen Contrast" settings set the range of contrast values for the operator.

The "Optimal Screen Contrast" setting sets the default value.

4.8 System Configuration

The ***System Configuration*** menu includes settings that are tailored to the specific machine. The "Altitude," "Drive Gas," "Heliox Mode," "$\dot{V}_E$ Alarm Limits," "System Type," and "Flow Sensor Correction" settings are present for all machines. The inclusion of the remaining settings depends on the purchased features for the specific machine.



Set the altitude

The accuracy of some of the ventilator measurements is altitude sensitive. To ensure the specified accuracy, the altitude setting should be set to the specific altitude where each machine is located.

Altitude settings range from -400 to 3600 meters in increments of 100 meters.

The setting is saved in EEPROM; the default value is 300 meters.

Select drive gas

Either O_2 or Air can be used as the drive gas for the ventilator's pneumatic engine.

To compensate volume calculations for the specific density of the drive gas used, the drive gas selection on this menu must match the actual drive gas.

To change the actual drive gas, refer to Section 4 of the respective anesthesia machine Technical Reference Manual.

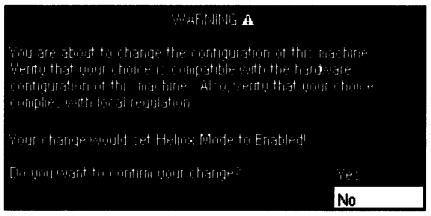
⚠ Caution If you change the drive gas, you must also change the drive gas selection on this service setup screen. If the drive gas selection and the actual drive gas do not agree, volumes will not be correct.

Heliox Mode **Enabled** – Disabled

Aespire 7100 machines can not be configured to deliver Heliox.

The Heliox Mode should be set to "Disabled". With the Heliox Mode disabled, the user's "Setup" menu will not include the Heliox option.

Whenever you enable or disable the Heliox Mode, the screen will display the following warning:



Note A similarly worded warning will appear when you change the "O_2 Monitoring," "Volume Monitoring," and the "Volume Compensation" settings.

$\dot{V}_E$ Alarm Limits **Automatic** – User Adjustable

System Type **Aestiva**

Currently, the 7100 ventilator is available in the Aestiva machine and the Aespire machine. Since the 7100 ventilator functions identically in either machine, the System Type setting is displayed as "Aestiva." The cursor will skip over this selection.

Flow Sensor Correction **Lead Filter Off** – Lead Filter On

This setting relates to the VMB board. For current VMB assemblies, this setting should be **Lead Filter Off**.

O_2 Monitoring **Enabled** – Disabled (if site preference)

May not appear in some configurations.

Volume Monitoring **Enabled** – Disabled (if site preference)

May not appear in some configurations.

If "Volume Monitoring" is set to "Disabled,"
"Volume Compensation" is automatically set to "Disabled."

Volume Compensation **Enabled** – Disabled (if site preference)

May not appear in some configurations.

Pressure Mode **Enabled** – Disabled (if site preference)

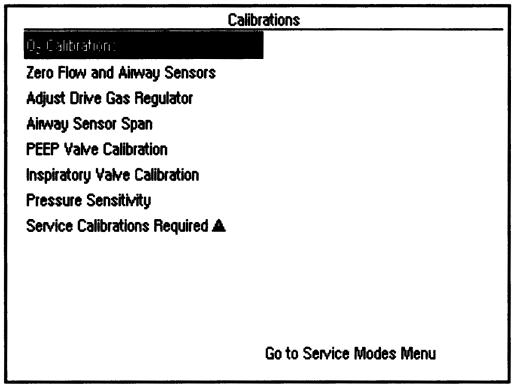
May not appear in some configurations.

Pressure Waveform **Enabled** – Disabled (if site preference)

May not appear in some configurations.

4.9 Calibrations

The ***Calibrations*** menu includes service level calibrations of components that need periodic adjustment to maintain specified accuracy.



Remarks You can enter these procedure in any order. However, the procedures appear in a logical sequence. Some of the latter procedures require you to have completed some of the earlier procedures.

Additionally, these procedures require you to disassemble and reassemble parts of the breathing system. Accordingly, the procedures are arranged to minimize the disassembly and reassembly process.

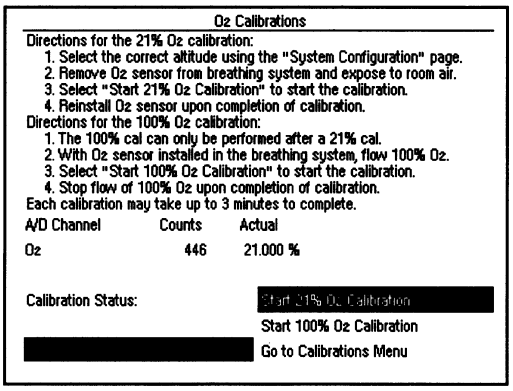
4.9.1 O_2 Calibrations

The ***O_2 Calibrations*** take into account the altitude setting. Before starting the calibrations, ensure that the altitude setting (in "System Configuration" menu) is set to the appropriate altitude for the machine location.

For the "21% O_2 Calibration" software reads the A/D value for the O_2 sensor when the O_2 sensor is exposed to room air (21% O_2).

- If this A/D value is not within the tolerance, the calibration fails.
- If the calibration passes, the A/D value is stored in the EEPROM.

The sensor must be calibrated at 21% O_2 before calibration at 100% O_2.



Remarks

Remove the O_2 sensor from the breathing system and expose it to room air. The displayed reading should be 21% ± 2% to pass the calibration requirements.

Place the sensor that passed the 21% test in the breathing system and expose it to 100% O_2.

If it displays readings higher or lower than required to pass, replace the sensor.

4.9.2 Zero Flow and Airway Sensors

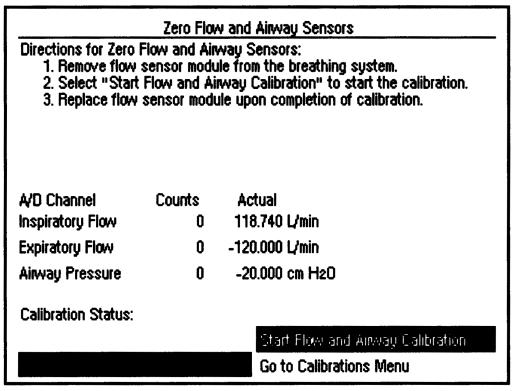
The ***Zero Flow and Airway Sensors*** procedure

- zeros any offset in the amplifier for the airway pressure sensor
- determines the zero value for the inspiratory flow and expiratory flow measurement differential pressure transducers.

It does so by reading the A/D values for inspiratory flow, expiratory flow, and airway pressure when the flow sensors have been disconnected from the breathing system.

- If the calibration passes, the offset and zero values are stored in the EEPROM.
- If the A/D values are not within the correct tolerance the calibration fails.

If the calibration fails, the screen will display the reason for the failure.



Remarks

Ensure that the flow sensor module is disconnected from the breathing system.

"Fail" indicates a problem in the VMB (Inspiratory Flow and Expiratory Flow transducers) or the VEB (Airway Pressure transducer).

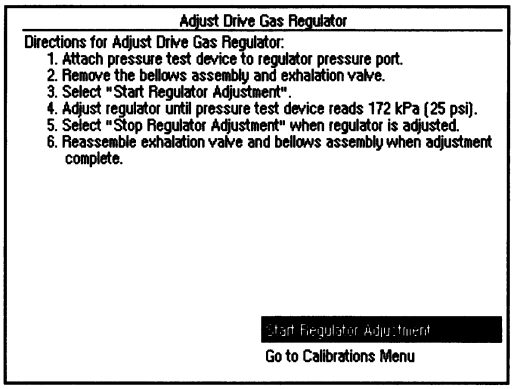
Check the transducer outputs using the "*Display A/D Channels*" menu (on "*Diagnostics*" *menu*).

If any of the transducers are out of tolerance:

- Follow Section 7.5.3, "Inaccurate Volume Ventilation Troubleshooting," for issues with inspiratory and expiratory flow transducers.
- Replace the VEB assemblies, for issues with the airway pressure transducer.

4.9.3 Adjust Drive Gas Regulator

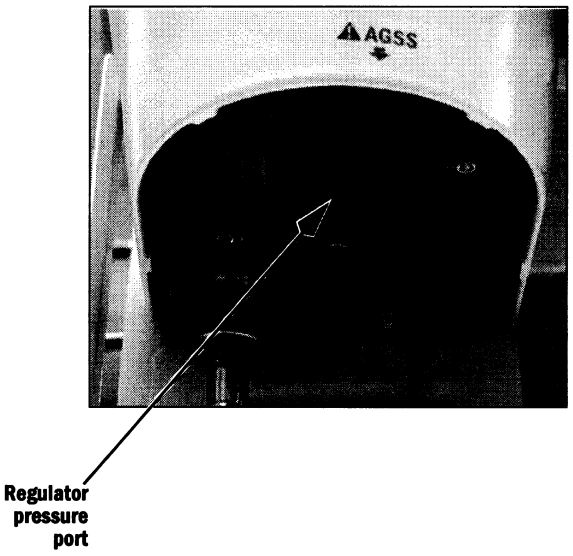
The ***Adjust Drive Gas Regulator*** procedure establishes the required flow rate through the drive gas regulator for proper calibration.



Remarks

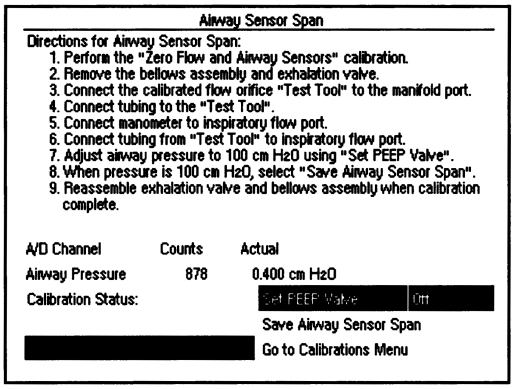
The drive gas regulator should provide a constant gas input pressure of 172 kPa (25 psi).

You can verify this pressure by attaching a pressure test device to the regulator pressure port (shown below) and adjusting the regulator to 172 ±1.72 kPa (25 ±0.25 psi).



4.9.4 Airway Sensor Span

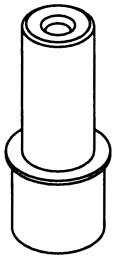
The ***Airway Sensor Span*** procedure calculates a gain coefficient for the airway pressure transducer.



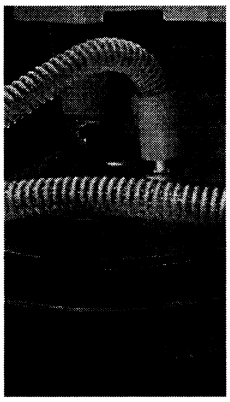
Calibration setup

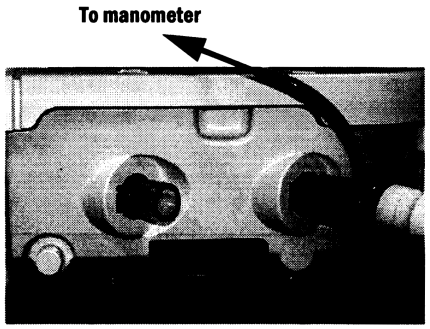
1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Separate the Bellows Module from the Circuit Module.
4. Install the Circuit Module only.
5. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.

   Note: The Calibrated Flow Orifice for the Aespire has the same orifice size as the Calibrated Flow Orifice for the Aestiva; however, the Aestiva orifice has a larger outside dimension that does not fit through the Vent Engine cover plate. To use the Aestiva orifice with an Aespire machine, you must remove the cover plate to access the manifold port.
6. Insert the Calibrated Flow Orifice into the manifold (PEEP) port.
7. Connect a pressure sensing tee to the inspiratory flow patient connection.
8. Connect the open end of the patient circuit tube to the flow port of the pressure sensing tee.
9. Connect a manometer to the pressure sensing port of the tee connector.



Calibrated Flow Orifice 1504-3016-000 for the Aespire machine





Calibration procedure

1. Select "Set PEEP Valve."
2. Adjust the PEEP Valve "counts" until the **manometer** reads 100 ±0.3 cm H_2O (this will be at counts greater than 2500).
3. Press the control knob to activate the test at the selected PEEP Valve counts.
4. With the manometer at 100 cm H_2O, select "Save Airway Sensor Span."

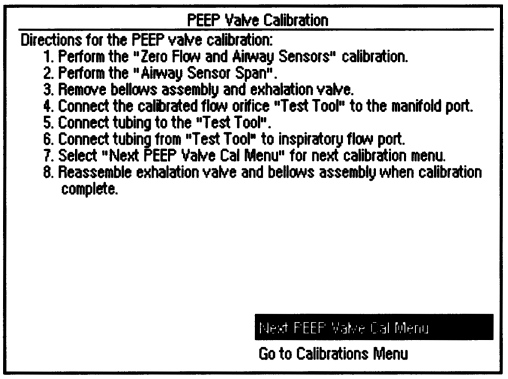
Remarks

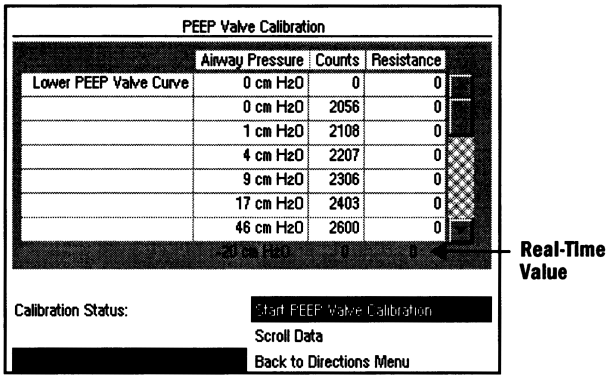
If the "Set PEEP Valve" value is set too high, pressure in the circuit may exceed 109 cm H_2O and trip the pressure limit switch. If this happens, lower the "Set PEEP Valve" value.

4.9.5 PEEP Valve Calibration

The ***PEEP Valve Calibration*** should be performed:

- when the machine is first put into service.
- at prescribed, planned maintenance intervals.
- after the pneumatic engine has been serviced.





Calibration setup

After completing the "Airway Sensor Span" calibration in the previous section, remove the pressure sensing tee and connect the open end of the patient circuit tube directly to the inspiratory flow patient connection.

- If you are only performing the PEEP Valve calibration, connect the Calibrated Flow Orifice as detailed in the "Airway Sensor Span" setup. Then, connect the open end of the patient circuit tube directly to the inspiratory flow patient connection.

Ensure that the test tubing is leak free.

Calibration procedure

1. To enter the calibration menu, select "Next PEEP Valve Cal Menu".
2. Establish drive gas for the ventilator.
3. Set all flow controls to minimum.
4. To start calibration, select "Start PEEP Valve Calibration".

Note: This calibration procedure may take up to 20 minutes.

The calibration status and progression bar are displayed at the bottom of the screen.

Remarks

The calibration routine opens the PEEP valve stepwise and reads the resulting airway pressure. The accumulated values represent the output linearity curve for this particular PEEP valve. The accumulated data include:

- Lower PEEP Valve Curve
- Upper PEEP Valve Curve
- PEEP Temperature Comp
- PEEP Nominal Resistance

The data is stored in EEPROM and is used during normal operation to compensate for the individual valves output characteristics.

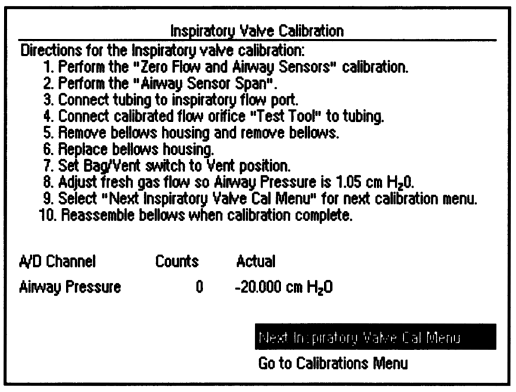
Scroll Data

To view the stored data, select "Scroll Data".

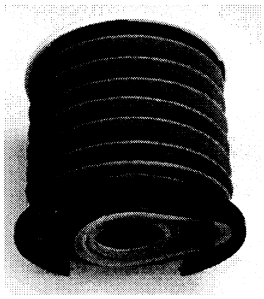
4.9.6 Inspiratory Valve Calibration

The ***Inspiratory Valve Calibration*** should be performed:

- when the machine is first put into service.
- at prescribed, planned maintenance intervals.
- after the pneumatic engine has been serviced.



Calibration setup



1. Remove the bellows and pressure relief valve (pop-off) from the bellows assembly.
   - Remove the bellow housing.
   - Remove the bellows and bellows mounting rim as an assembly.
   - Remove the pressure relief valve.
   - Replace the bellows housing.
   - **Note:** If you have just completed the PEEP Valve Calibration, remove these parts from the bellows assembly and then reassemble the breathing system.
2. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.
3. Connect the open end of the patient circuit tube to the inspiratory flow patient connection.
4. Set the Bag/Vent switch to Vent.
5. Establish drive gas for the ventilator.
6. Adjust fresh gas flow so the actual Airway Pressure reads 1.05 cm H_2O.

Calibration procedure

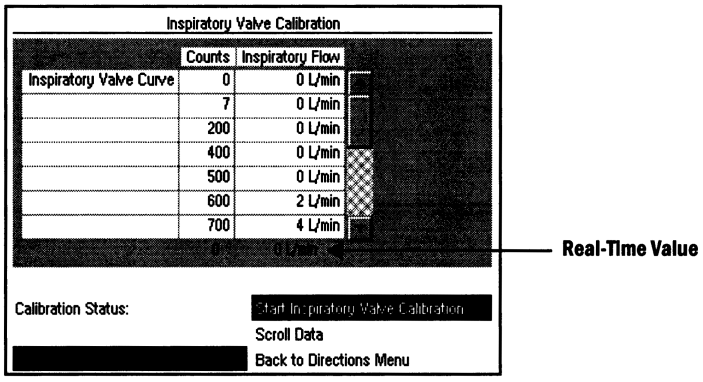
1. To enter the calibration menu, select "Next Inspiratory Valve Cal Menu".
2. To start calibration, select "Start Inspiratory Valve Calibration".

Note: This calibration procedure may take up to 5 minutes.

The calibration status and progression bar are displayed at the bottom of the screen.

Note

For the color display, if the message ***Complete! Max flow may be low*** ⚠ is displayed, the jumpers on the Control Board may be installed incorrectly (refer to Section 10.25.1).



Remarks

With the bellows removed from the bellows assembly, the output from the inspiratory valve is routed through the breathing system to the Airway Pressure transducer. The calibrated orifice provides a precise restriction to the flow.

The calibration routine opens the Inspiratory valve stepwise and reads the resulting pressure at the airway pressure transducer. The inspiratory flow displayed on the screen for this test is a calculation of the pressure measured by the airway pressure transducer times a constant (based on the size of the orifice in the test tool).

The accumulated values represent the output linearity curve for this particular Inspiratory valve.

The data is stored in EEPROM and is used during normal operation to compensate for the individual valves output characteristics.

Scroll Data

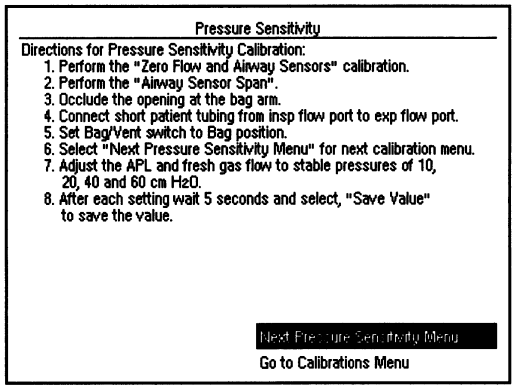
To view the stored data, select "Scroll Data".

4.9.7 Pressure Sensitivity

The ***Pressure Sensitivity*** calibration calculates correction factors for common mode pressure sensitivity of the differential pressure transducers. The pressure transducers must be calibrated whenever the VMB or the Control Board is replaced.

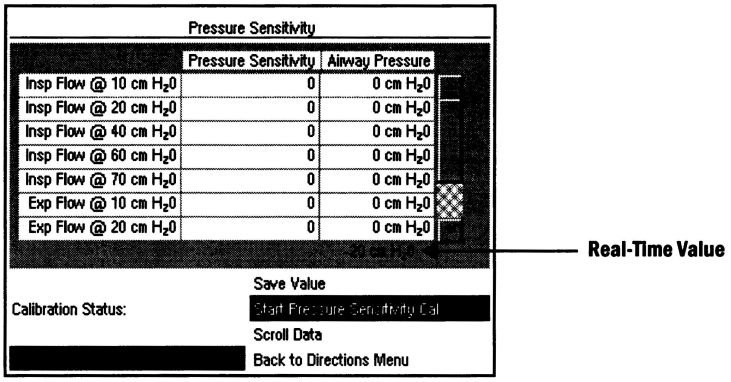
This pressure sensitivity calibration is not an automated calibration. Follow the prompts on the screen to complete the calibration. The routine calculates the pressure sensitivity at four different pressures (10, 20, 40, and 60 cm H_2O) and extrapolates the fifth pressure point (70 cm H_2O). It uses these five pressure points along with the zero offsets to find the pressure sensitivity.

- If the calibration passed, the five pressure sensitivity points are stored in the EEPROM.
- If the calculations for the pressure sensitivity are not within the correct tolerance, the calibration fails.



Calibration procedure

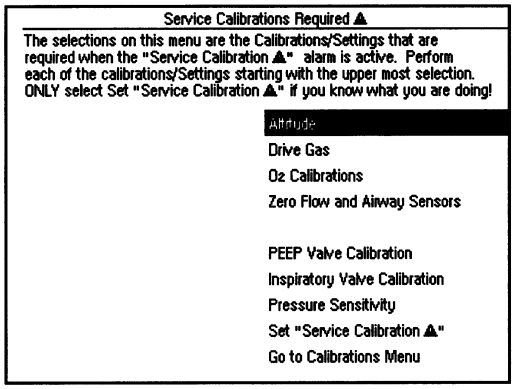
1. Perform the "Zero Flow and Airway Sensors" calibration.
2. Perform the "Airway Sensor Span".
3. Occlude the opening at the bag arm
4. Connect short patient tubing from the inspiratory flow patient connection to the expiratory flow patient connection.
5. Set the Bag /Vent switch to the Bag position.
6. Select "Next Pressure Sensitivity Menu" for the next calibration menu.



7. To start calibration select "Start Pressure Sensitivity Cal".
   - Adjust the APL and fresh gas flow until the real-time pressure reads a **stable 10 cm H_2O** – after 5 seconds, select "Save Value".
   - Adjust the APL and fresh gas flow until the real-time pressure reads a **stable 20 cm H_2O** – after 5 seconds, select "Save Value".
   - Adjust the APL and fresh gas flow until the real-time pressure reads a **stable 40 cm H_2O** – after 5 seconds, select "Save Value".
   - Adjust the APL and fresh gas flow until the real-time pressure reads a **stable 60 cm H_2O** – after 5 seconds, select "Save Value".

4.9.8 Service Calibrations Required

The ***Service Calibrations Required*** ⚠ menu displays which setting or calibration must be performed when the "Service Calibration ⚠" alarm appears in normal operation. After the setting or calibration is properly completed, the text for that setting or calibration will be removed.

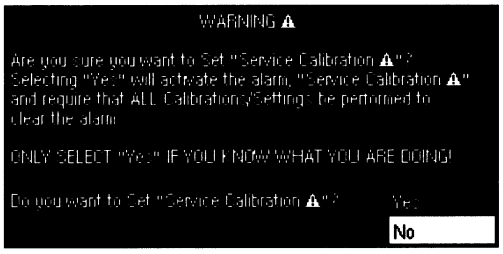


Remarks

The normal operation "Service Calibration ⚠" alarm message is only removed when all the required settings or calibrations are completed.

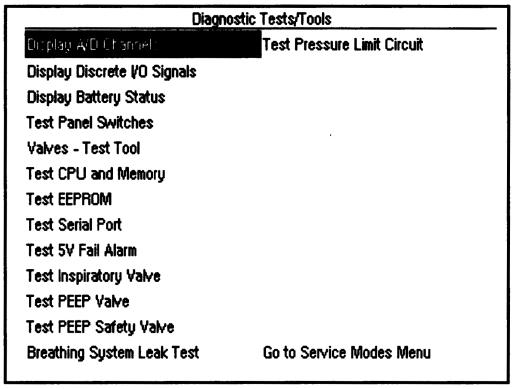
The ***Set "Service Calibration ⚠"*** menu item is used by the factory to activate the "Service Calibration ⚠" alarm and require that all settings and calibrations be performed when the machine is set up for operation at its permanent location.

You can reset the "Service Calibration ⚠" alarm in the field by selecting "Yes" when the following warning appears after selecting the "Set Service Calibration ⚠" menu item.



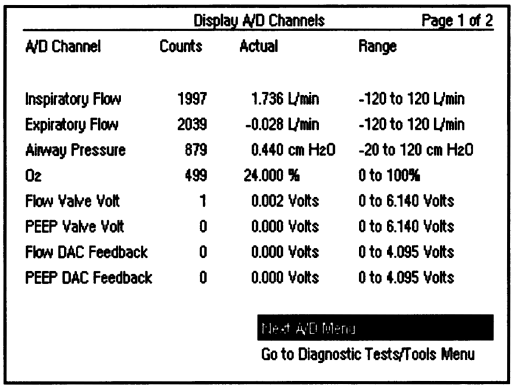
4.10 Diagnostic Tests/Tools

The ***Diagnostic Tests/Tools*** menu includes a selection of items that look at individual subsystems of the 7100 Ventilator.



4.10.1 Display A/D Channels

The ***Display A/D Channels*** menu displays the measured values for each of the A/D channels.

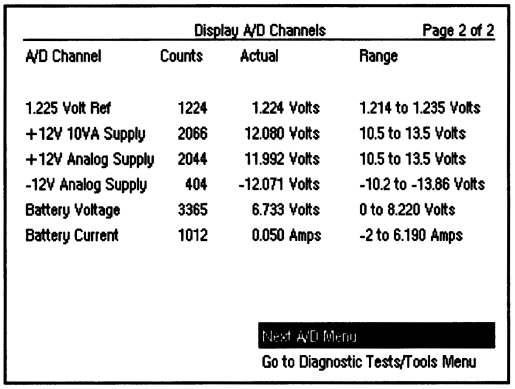


Display A/D Channels — Page 1 of 2

A/D Channel	Counts	Actual	Range
Inspiratory Flow	1997	1.736 L/min	-120 to 120 L/min
Expiratory Flow	2039	-0.028 L/min	-120 to 120 L/min
Airway Pressure	879	0.440 cm H2O	-20 to 120 cm H2O
O2	499	24.000 %	0 to 100%
Flow Valve Volt	1	0.002 Volts	0 to 6.140 Volts
PEEP Valve Volt	0	0.000 Volts	0 to 6.140 Volts
Flow DAC Feedback	0	0.000 Volts	0 to 4.095 Volts
PEEP DAC Feedback	0	0.000 Volts	0 to 4.095 Volts

Next A/D Menu

Go to Diagnostic Tests/Tools Menu



Display A/D Channels — Page 2 of 2

A/D Channel	Counts	Actual	Range
1.225 Volt Ref	1224	1.224 Volts	1.214 to 1.235 Volts
+12V 10VA Supply	2066	12.080 Volts	10.5 to 13.5 Volts
+12V Analog Supply	2044	11.992 Volts	10.5 to 13.5 Volts
-12V Analog Supply	404	-12.071 Volts	-10.2 to -13.86 Volts
Battery Voltage	3365	6.733 Volts	0 to 8.220 Volts
Battery Current	1012	0.050 Amps	-2 to 6.190 Amps

Next A/D Menu

Go to Diagnostic Tests/Tools Menu

Remarks

The ***Counts*** and ***Actual*** values are typical for a calibrated system with baseline inputs to the various sensors.

Refer to the following table for additional details for each of the displayed channels.

A/D Channel	Counts[1] (range)	Actual[2]	Range	Comments
Inspiratory Flow	2050 (1800-2300)	0.000 L/min	-120 to 120 L/min	Zero Offset Reading (nominal 2050 Counts) Increased flow = more counts/more positive
Expiratory Flow	2050 (1800-2300)	0.000 L/min	-120 to 120 L/min	Zero Offset Reading (nominal 2050 Counts) Increased flow = less counts/more negative
Airway Pressure	800 (550-1050)	0.000 cmH20	-20 to 120 cmH20	Zero Offset Reading (nominal 800 Counts)
O_2	377 (0-4095)	21.000%	0 to 100%	Count weight and limits are determined during O_2 calibration
Flow Valve Volt	0 (0-4095)	0.000 Volts	0 to 6.140 Volts	
PEEP Valve Volt	0 (0-4095)	0.000 Volts	0 to 6.140 Volts	
Flow DAC Feedback	0 (0-4095)	0.000 Volts	0 to 4.095 Volts	
PEEP DAC Feedback	0 (0-4095)	0.000 Volts	0 to 4.095 Volts	
1.225 Volt Ref	1.225 (1214-1235)	1.225 Volts	1.214 to 1.235 Volts	
+12V 10VA Supply	2041	11.975 Volts	10.5 to 13.5 Volts	12V-10VA Test Out-of-Range (Minimum Shutdown)
+12V Analog Supply	2050	12.027 Volts	10.5 to 13.5 Volts	+12V Analog Out-of-Range (Minimum Shutdown)
-12V Analog Supply	396	-12.071 Volts	-10.2 to -13.86 Volts	-12V Analog Out-of-Range (Minimum Shutdown)
Battery Voltage	3609	7.215 Volts	0 to 8.220 Volts	> 8 Volts (10 sec) = Battery Failure High < 5.65 Volts = Low Battery Voltage < 2 Volts = Battery Failure Low
Battery Current	997	-0.008 Amps	-2 to 6.190 Amps	< -750 mA = Battery Charger Fail -330 to -700 mA (1 min) = Battery charging ⚠ >600 mA (10 sec)= On Battery-Power OK? >6 Amps (10 sec) = Battery Current High

Notes:

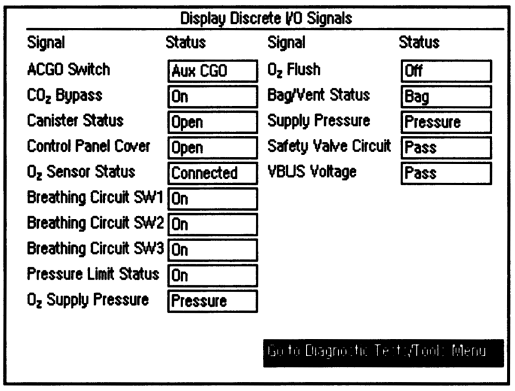
1. The ***Counts*** column shows typical digital counts from the computer with the expected (***range***) shown in parenthesis.
2. The ***Actual*** column shows current values in real time with inputs in their baseline state.

4.10.2 Display Discrete I/O Signals

The ***Display Discrete I/O Signals*** menu displays discrete binary signals associated with machine switch positions.

There are several types of switches in the machine:

- some switches are mechanically operated,
- some switches are pneumatically operated,
- some switches are electronic,
- some "switches" are software derived.



Mechanical switches

- ACGO Switch – Vent or Aux CGO (machines equipped with ACGO)
- CO_2 Bypass – Off or On (hard-wired On if Canister Release switch is installed)
- Canister Status – Closed or Open
  (Closed by default if Canister Release switch not installed)
- Control Panel Cover – Closed or Open (refers to removal of ABS on Aespire machines)
- Bag/Vent Status – Vent or Bag

Pneumatic switches

- O_2 Supply Pressure – Pressure or No Pressure
- O_2 Flush – Off or On
- Supply Pressure – Pressure or Low Pressure (drive gas)

Electronic switches

- O_2 Sensor Status – Connected or Disconnected

Breathing Circuit Switches (Circuit module ID):
In Aespire 7100 machines, the switch positions are hard-wired on the VMB to indicate Circle patient circuit.

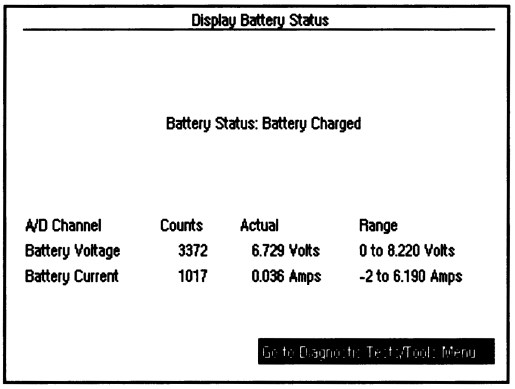
- Breathing Circuit SW1 – Off
- Breathing Circuit SW2 – Off
- Breathing Circuit SW3 – On
- Pressure Limit Status – Off or On (if Paw exceeds 108 cm H_2O)

Software "switches"

- Safety Valve Circuit – Pass or Fail
- VBUS Voltage – Pass or Fail

4.10.3 Display Battery Status

The ***Display Battery Status*** menu displays the battery charge status.



Battery Status (on line power)

"Battery Charged" – If none of the following conditions are in effect.

"Battery Charging ⚠" – Battery Current = -330 to -700 mA

"Battery Failure Low" – Battery Voltage <2 Volts

"Battery Failure High" – Battery Voltage >8 Volts

"Battery Current High" – Battery Current >6 Amps

"Battery Charger Fail" – Battery Current < -750 mA

Battery Status (on battery power)

"On Battery-Power OK?" – System is running on battery.

"Low Battery Voltage" – Battery Voltage <5.65 Volts

Remarks

While the battery is charging, the battery current is displayed as negative current. If the battery has been on charge for a long time (8 hours minimum) and you do not get a "Battery Charged" display:

- The battery has failed and you should replace it.

When the battery is discharging, the battery current is displayed as positive current. Disconnect the power cord and observe the discharge current.

- A good, fully-charged battery should maintain a steady discharge current (for at least 30 minutes under normal operation).
- If the discharge current and battery voltage drops off quickly, the battery has failed and you should replace it.

⚠ Warning Depending on the battery condition and the ventilator settings, continued operation of the mechanical ventilation may result in sudden shut down.

4.10.4 Test Panel Switches

In the ***Test Panel Switches*** menu the software is set up to receive keyboard button presses and rotary encoder turns.

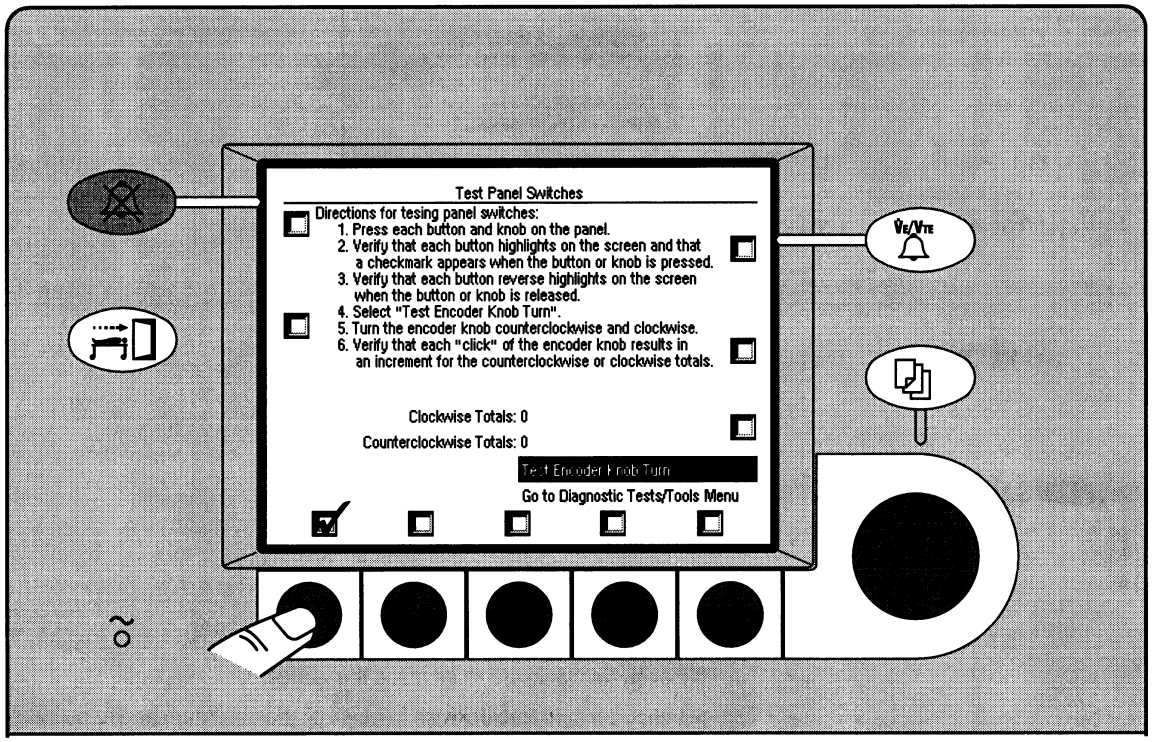
Press each button on the panel and the control knob.

- When a button is pressed, the icon on the screen next to the button should be highlighted and filled with a checkmark.
- When the button is released, the button icon should be reverse-highlighted.

After testing all the buttons and the control knob, select "Test Encoder Knob Turn" to test the encoder.

As you turn the encoder knob, verify that:

- each click of the encoder in the clockwise direction increments the clockwise total.
- each click of the encoder in the counterclockwise direction increments the counterclockwise total.



Remarks If any of the select buttons test fails, replace the front panel keyboard assembly.

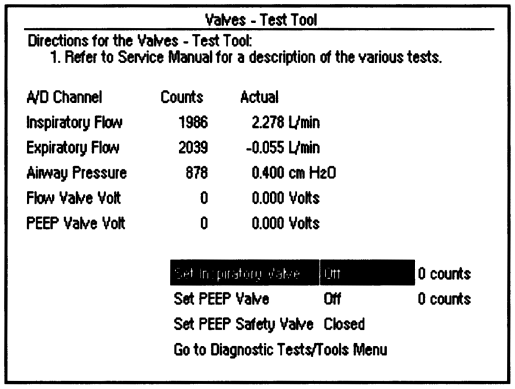
If the encoder knob test fails, replace the rotary encoder assembly.

4.10.5 Valves - Test Tool

The ***Valves - Test Tool*** menu allows you to manually control the Inspiratory Valve, the PEEP Valve, and the PEEP Safety Valve, and observe key pressure and flow measurements on the same screen.

This menu is mainly used to test the drive gas circuit or to supply drive gas flow for several tests:

- It is used to test the mechanical overpressure valve as detailed in Section 6.4, "MOPV pressure relief valve test."
- It is used to check primary regulators as detailed in Section 5.1.2.



Set Inspiratory Valve

The flow through the Inspiratory Valve can be set:

- from **Off** to **70 L/min** in 0.25 L/min increments.

Set PEEP Valve

The PEEP Valve can be set:

- from **Off** to **100 cm H_2O** in 0.5 cm H_2O increments.

Set PEEP Safety Valve

The PEEP Safety Valve can be set:

- **Closed** or **Open**

Remarks

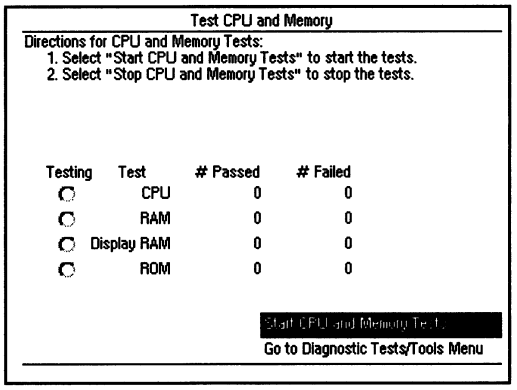
When setting the Inspiratory Valve or the PEEP Valve:

- Turn the encoder clockwise to increase the values.
- Turn the encoder counterclockwise to begin at the maximum and to decrease the values.

4.10.6 Test CPU and Memory

When you start the ***CPU and Memory Tests***, the procedure cycles through the CPU, RAM, Display RAM, and ROM tests until you stop the tests. The procedure keeps track of how many times each test passed or failed.

If you note that any of these tests have failed, replace the control board.



CPU Test The software tests the CPU integer instructions as well as the CPU register(s). If this test fails, the CPU did not perform an integer instruction correctly, or the CPU register(s) have failed.

RAM Test The software tests all of the external RAM memory with a walking bit pattern test. It writes a certain bit pattern to a block of memory and then reads that block of memory. If the bit pattern that it wrote is not the same bit pattern that it reads back the test fails.

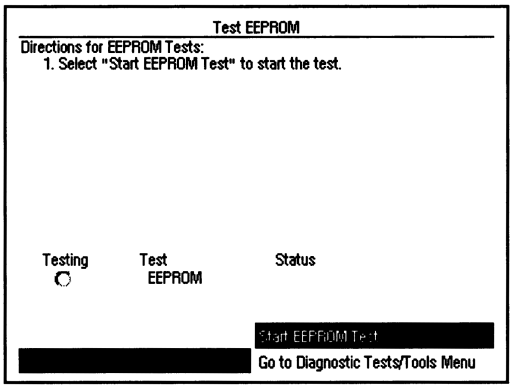
Display RAM Test The software tests all of the display RAM memory via a walking bit pattern test. It writes a certain bit pattern to a block of memory and then reads that block of memory. If the bit pattern that was written is not the same bit pattern that it reads back the test fails.

ROM Test The software tests the Flash ROM via a CRC check (Cyclic Redundancy Check). A CRC value has been calculated for the Flash ROM memory and this value is stored in the Flash ROM. This test recalculates the CRC for the Flash ROM and compares it to the value stored in Flash ROM. If the value that was calculated does not equal the value that was stored in Flash ROM, the test will fail.

4.10.7 Test EEPROM

When you start the ***EEPROM Test***, the procedure performs the test once and notes whether the test passed or failed.

If the EEPROM test fails, replace the control board.



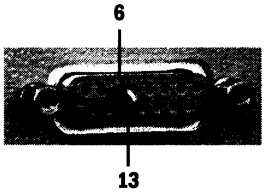
EEPROM Test

The software tests all of the EEPROM memory via a bit pattern test. It writes a certain pattern to a block of memory and then reads that block of memory. If the bit pattern that was written is not the same as the bit pattern read back, the test fails.

4.10.8 Test Serial Port

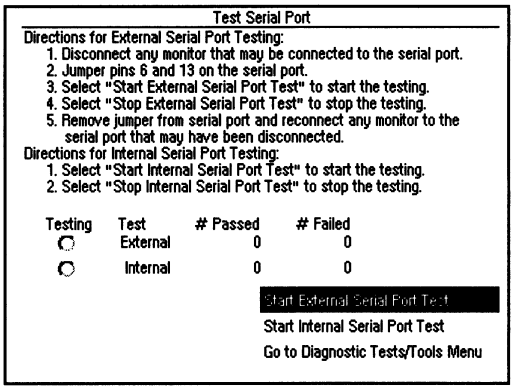
The ***Test Serial Port*** menu includes directions for two tests.

- **External Serial Port Testing**: The external test requires that you jumper pins 6 and 13 of the serial connector.



- **Internal Serial Port Testing**: The internal test does not require any setup; it only tests serial port related components on the control board.

Each test routine sets up the serial port circuits so transmit data is echoed directly back to the receive circuits. The test fails if the data sent out is not equal to the data received.



Remarks If only the internal test fails, replace the control board.

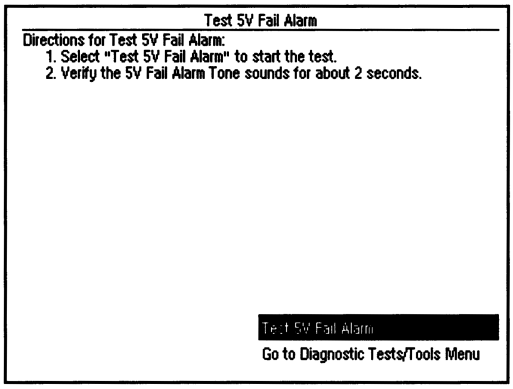
If both tests fail:

- Check the harness connections between the control board and the Serial Isolation Control board (SICB).
- Replace the SICB.

4.10.9 Test 5V Fail Alarm

The 5-Volt supply (VDD) is derived in the power section of the control board. It is used to power the digital circuits throughout the ventilator. If the 5-Volt supply fails, the ventilator will sound a continuous alarm tone when the system switch is turned on.

To ***Test the 5V Fail Alarm***, follow the directions on the screen.



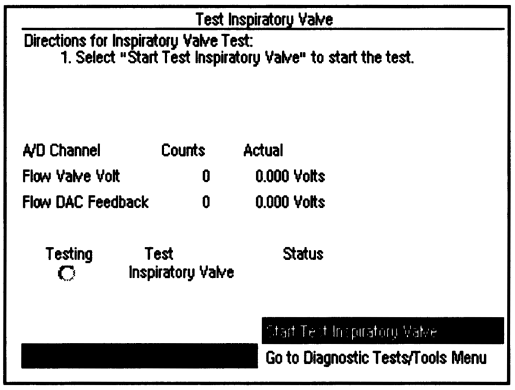
Remarks If the alarm tone does not sound, replace the control board.

4.10.10 Test Inspiratory Valve

This test only checks the control circuit for the Inspiratory Valve. Since it does not look at the output of the Inspiratory Valve, you do not have to have an active drive gas supply.

To ***Test the Inspiratory Valve*** the software opens the inspiratory valve in increments until the flow valve is completely open.

- At each of the settings of the inspiratory valve the A/D channel for Flow DAC Feedback is recorded.
- If the A/D for the Flow DAC Feedback is not within the correct tolerance the test fails.

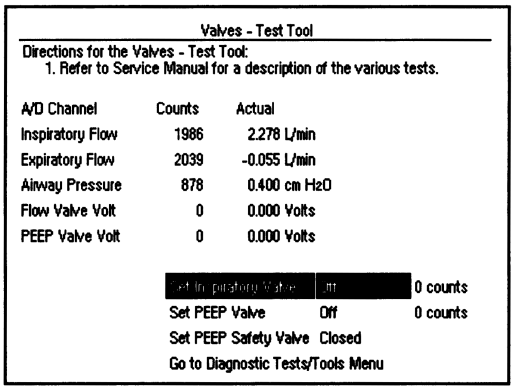


Remarks

A failure can be caused either by the control circuit or a flow valve malfunction.

To check the control circuit,

1. Go to the "Valves - Test Tool" menu.



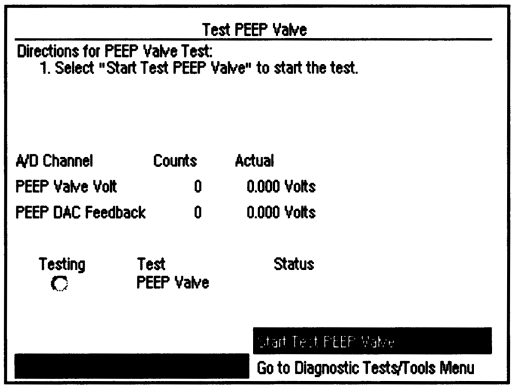
2. Set the Inspiratory Valve to 0.25 L/min. The "Flow Valve Volt" reading should increase slightly.
3. If the reading jumps high (~ 6 Volts), the control circuit for the Inspiratory Valve is open or the Inspiratory Valve is defective.
4. Measure the resistance between the leads at the unplugged Inspiratory Valve connector. A multimeter should read 1.5 ±0.15 ohms.

4.10.11 Test PEEP Valve

This test only checks the control circuit for the PEEP Valve. Since it does not look at the output of the PEEP Valve, you do not have to have an active drive gas supply.

To ***Test the PEEP Valve*** the software opens the PEEP valve in increments until the PEEP valve is completely open.

- At each of the settings of the PEEP valve the A/D channel for PEEP DAC Feedback is recorded.
- If the A/D for the Flow DAC Feedback is not within the correct tolerance the test fails.

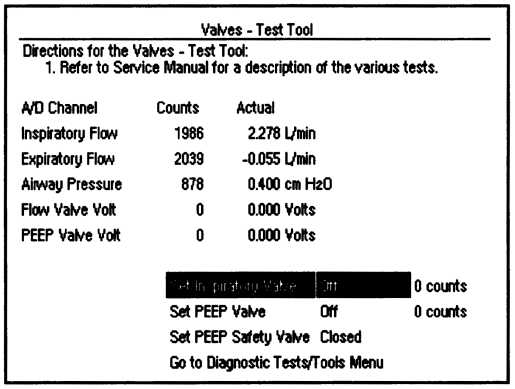


Remarks

A failure can be caused either by the control circuit or a PEEP Valve malfunction.

To check the control circuit,

1. Go to the "Valves - Test Tool" menu.



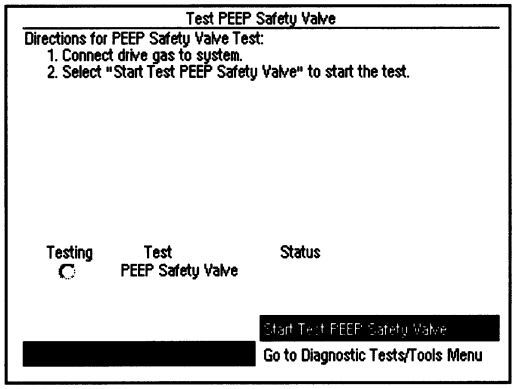
2. With the PEEP Valve set to "Off", the "PEEP Valve Volts" should read near 0.000 Volts.
3. If the reading is high (~ 6 Volts), the control circuit for the PEEP Valve is open or the PEEP Valve is defective.
4. Measure the resistance between the open terminals of the PEEP Valve (blue). A multimeter should read 10 ±1 ohm.

4.10.12 Test PEEP Safety Valve

This test requires an active drive gas supply.

To ***Test the PEEP Safety Valve*** the software opens the PEEP Safety Valve and checks the output of the Supply Pressure Switch.

- If the Supply Pressure Switch detects pressure, the PEEP Safety Valve test passes.
- If the Supply Pressure Switch does not detect pressure, the PEEP Safety Valve test fails.

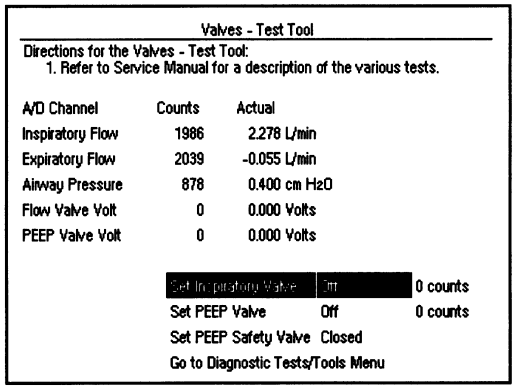


Remarks

A failure can be caused either by the control circuit or a PEEP Safety Valve malfunction.

To check the control circuit,

1. Go to the "Valves - Test Tool" menu.

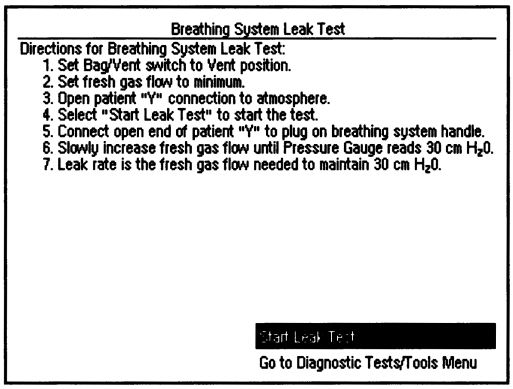


2. Set the PEEP Safety Valve to "Open" and listen for a "click" in the area of the pneumatic engine.
3. If you do not hear a "click" each time the PEEP Safety Valve is opened, the control circuit to the PEEP Safety Valve is open or the PEEP Safety Valve is defective.
4. Measure the resistance between the open terminals of the PEEP Safety Valve (white). A multimeter should read 10 ±1 ohm.

4.10.13 Breathing System Leak Test

You can estimate how much of a leak there is in the ventilator portion of the breathing system by closing the patient circuit, inflating the bellows, and observing how quickly they fall on their own weight (part of machine checkout procedure).

The ***Breathing System Leak Test*** allows you to more precisely test the ventilator portion of the breathing system for leaks.



Note regarding plug:

On an Aespire machine the plug is located on the side of the ABS.

Remarks

By using the patient circuit to establish a closed loop, you can measure the leak rate.

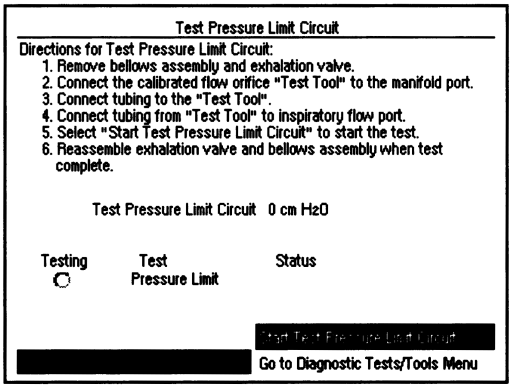
- The leak rate is the fresh gas flow needed to maintain 30 cm H_2O.
- The system should have a leak rate < 200 mL/min.

4.10.14 Test Pressure Limit Circuit

The airway pressure limit circuit should trip at approximately 109 cm H_2O.

The ***Test Pressure Limit Circuit*** routine:

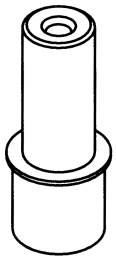
- establishes a closed patient airway circuit,
- increments the pressure in the airway circuit,
- observes the output of the airway pressure transducer,
- notes at what pressure the "pressure limit circuit" trips.



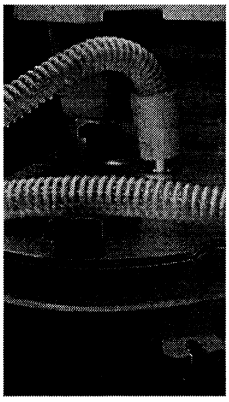
Test setup

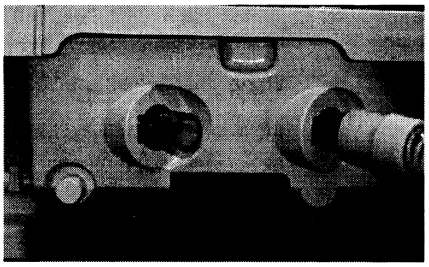
1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Separate the Bellows Module from the Circuit Module.
4. Install the Circuit Module only.
5. Set the Bag/Vent switch to Vent.
6. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.

   Note: The Calibrated Flow Orifice for the Aespire has the same orifice size as the Calibrated Flow Orifice for the Aestiva; however, the Aestiva orifice has a larger outside dimension that does not fit through the Vent Engine cover plate. To use the Aestiva orifice with an Aespire machine, you must remove the cover plate to access the manifold port.
7. Insert the Calibrated Flow Orifice into the manifold (PEEP) port.
8. Connect the open end of the patient circuit tube to the inspiratory flow patient connection.



Calibrated Flow Orifice 1504-3016-000 for the Aespire machine





Test Procedure

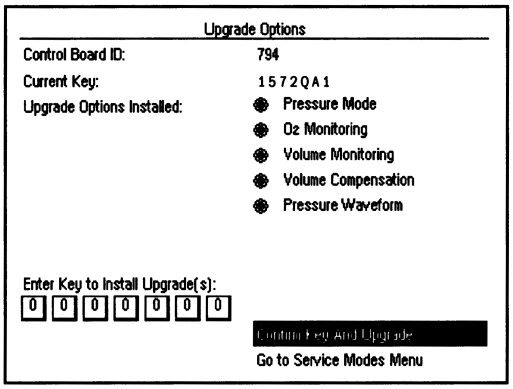
1. Select "Start Test Pressure Limit Circuit" to start the test.

If the "Test Pressure Limit Circuit" trip point is approximately 109 cm H_2O, the test passes.

4.11 Upgrade Options

The ***Upgrade Options*** menu shows what features are currently available in the ventilator's software.

The ventilator can be upgraded to include additional features by entering the upgrade "Key Code" that the customer has purchased.



Remarks Select each "digit" in the "Enter Key to Install Upgrade(s):" field and rotate the control knob to select the corresponding digit in the Key Code.

When you have entered all the digits, select "Confirm Key And Upgrade."

After verifying the Key Code match to the Control Board ID, the menu will display the newly installed features.

Note If the ventilator "Key Code" is changed, the new code should be recorded on the display module rear panel label.

5 Calibration

⚠ WARNING After adjustments and calibration are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

In this section This section covers calibration procedures for components of the Aespire anesthesia machine.

5.1 Primary Regulators 5-2

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5.1 Primary Regulators

Follow the procedure in Section 5.1.1 to gain access to the regulators. Then, in Section 5.1.2, select the test that is appropriate for the regulator you are testing.

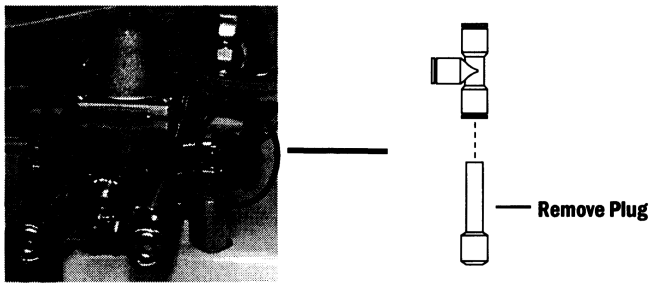
⚠ WARNING When testing/adjusting N_2O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

5.1.1 Test setup

⚠ WARNING Wear safety glasses while test device is connected to the test port.

⚠ CAUTION Be careful not to plug the output of the primary regulator without having a pressure relief valve in the output circuit.

1. Set the system switch to Standby.
2. Disconnect all pipeline supplies.
3. Remove the upper rear panel (Section 9.2).
   For 3rd gas cylinder regulators, also remove the lower rear panel.
4. If equipped, turn the auxiliary O_2 flowmeter control fully clockwise (no flow).
5. Install a full cylinder in the cylinder supply to be tested. It is essential that the cylinder be within 10% of its full pressure.
6. Remove the plug from the test port and connect a test device capable of measuring 689 kPa (100 psi).



5.1.2 Testing Primary Regulators

There are two variations of the test procedure for the primary regulators:

- Test A – For primary regulators that supply drive gas to the ventilator.
- Test B – For all gases not used to supply drive gas to the ventilator.

Test A

For primary regulators that supply drive gas to the ventilator (O_2 or Air):

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 4. Under high flow conditions, the output pressure should not drop below the specifications in step 12.

1. Remove the bellows assembly.
2. Slowly open the cylinder valve.
3. Set the system switch to On.
4. **Low Flow Test:** Set the fresh gas flow to 0.05 L/min (or minimum flow for O_2). When checking an Air regulator on systems that have a single flowtube, open the needle valve 1/8 turn from the minimum stop to achieve a flow close to 0.05 L/min.
   - Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder gauge (upper limit of the red band). The flow may be temporarily increased to facilitate the decay.
   - At the time that the cylinder pressure reaches 2068 kPa (300 psi), set the system switch to Standby.
   - Within one minute, the test device must stabilize between:

     (60) DIN 372–400 kPa (54–58 psi)

     (50) Pin Indexed 310–341 kPa (45.0–49.5 psi).

     - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
     - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).
5. Slowly open the cylinder valve.
6. Enter the Service Mode:
   (Push and hold the adjustment knob on the ventilator's display and set the system switch to On.)
7. Select and confirm "Service Modes."
8. Follow the menu structure outline below to reach the adjustment for the inspiratory flow valve. Select and confirm at each step.
   - "Diagnostics Tests/Tools"
   - "Valves - Test Tool"
   - "Set Inspiratory Valve"

9. **High Flow Test:** Rotate adjustment knob counterclockwise to obtain 65 (L/min):

   - While watching the test device press confirm.
   - After 2 seconds, select "Go to Diagnostic Tests/Tools Menu" and press confirm to stop the gas flow.
   - The minimum test device reading observed must be greater than:

   (60) DIN 221 kPa (32 psi)

   (50) Pin Indexed 207 kPa (30 psi)

   Repeat this step three times.

   If the test device reading under "high flow" conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the "low flow" regulated output to the high side of the specification so that the "high flow" regulated pressure can fall within the specification.

   If the regulator subsequently fails the "low flow" specification (step 4) because the reading is too high, replace the cylinder supply.

10. Set the system switch to Standby.
11. Close the cylinder valve.
12. Bleed the system of all pressure.
13. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
14. Replace the bellows assembly.
15. Replace the rear panel(s).
16. Perform the checkout procedure (Section 3).

Test B **For all gases not used to supply drive gas to the ventilator:**

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 4. Under high flow conditions, the output pressure should not drop below the specifications in step 7.

1. If the cylinder supply being tested is N_2O, connect a source of O_2 and set the O_2 flow control to the minimum stop (pilot pressure for secondary regulator).
2. Slowly open the cylinder valve for the regulator being tested.
3. Set the system switch to On.

4. **Low Flow Test:** Set the flow of the gas being tested to 0.05 L/min (or minimum flow for O_2). When checking a regulator on systems that have a single flowtube, open the needle valve 1/8 turn from the minimum stop to achieve a flow close to 0.05 L/min.
   - Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder gauge (upper limit of the red band). The flow may be temporarily increased to facilitate the decay.
   - At the time that the cylinder pressure reaches 2068 kPa (300 psi), set the system switch to Standby.
   - Within one minute, the test device must stabilize between:

     (60) DIN 372–400 kPa (54–58 psi)

     (50) Pin Indexed 310–341 kPa (45.0–49.5 psi).

     - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
     - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).
5. Slowly open the cylinder valve.
6. Set the system switch to On.
7. **High Flow Test:** Set the flow control valve to the maximum indicated flow on the flow tube.
   - The test device reading must be greater than:

     (60) DIN 221 kPa (32 psi)

     (50) Pin Indexed 221 kPa (32 psi)

     - If the test device reading under "high flow" conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the "low flow" regulated output to the high side of the specification so that the "high flow" regulated pressure can fall within the specification.
     - If the regulator subsequently fails the "low flow" specification (step 4) because the reading is too high, replace the cylinder supply.
8. Set the system switch to Standby.
9. Close the cylinder valve.
10. Bleed the system of all pressure.
11. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
12. Replace the rear panel(s).
13. Perform the checkout procedure (Section 3).

5.1.3 Adjusting Primary Regulators

Important: Cylinder supplies in an Aespire machine must have all primary regulators set to the same pressure range: (50) Pin Indexed or (60) DIN. If a regulator is replaced, the replacement regulator must be set (as required) to the same specification as the one removed.

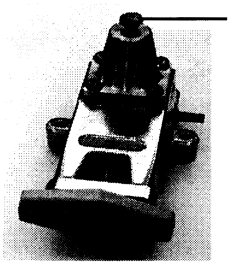
Important: Install a full cylinder in the cylinder supply to be adjusted. It is essential that the cylinder be within 10% of its full pressure.

If the cylinder supply being adjusted is N_2O, connect a source of O_2 and set the O_2 flow control to the minimum stop (pilot pressure for secondary regulator).

To adjust the primary regulators, follow the procedure in Section 5.1.1 to gain access to the regulators.

Do not attempt to adjust without flow.

1. Slowly open the cylinder valve.
2. Set the system switch to On.
3. Set and maintain the fresh gas flow of the gas being tested to 0.05 L/min (or minimum flow for O_2). When adjusting a regulator on systems that have a single flowtube, open the needle valve 1/8 turn from the minimum stop to achieve a flow close to 0.05 L/min.



4. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder gauge (upper limit of the red band). The flow may be temporarily increased to facilitate the decay.
5. When the cylinder gauge reaches the upper limit of the red band, adjust the regulator output pressure to:

   (60) DIN 386–400 kPa (56–58 psi)

   (50) Pin Indexed 327–341 kPa (47.5–49.5 psi).

   Note: It may be necessary to open the cylinder valve and repeat steps 4 and 5 a number of times to achieve the above setting.
6. Test the regulator settings per the appropriate test in Section 5.1.2:
   - **Test A** — For primary regulators that supply drive gas to the ventilator.
   - **Test B** — For all gases not used to supply drive gas to the ventilator.

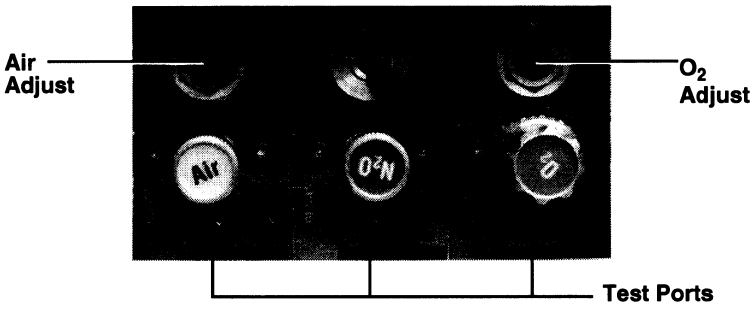
5.2 Secondary Regulators

⚠ WARNING When testing N_2O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

5.2.1 Testing/Adjusting Secondary Regulators or Balance Regulators

1. Set the system switch to Standby.
2. Remove the flowmeter panel shield (Section 9.7.1).
3. Remove the plug from the test port and connect a test device capable of measuring 689 kPa (100 psi) using 1/8-inch nylon tubing.

Note: Current production machines do not include a secondary regulator in the Air flowhead module.



4. Set the flow of the tested gas and of O_2 as detailed in the chart.
5. Verify that the output of the tested regulator is within the range listed in the chart.

Regulator	Output	Flow Regulated gas	Flow O_2
O_2	207 ±7 kPa (30 ±1 psi)	2 L/min	--------
Air	207 ±7 kPa (30 ±1 psi)	2 L/min	--------
N_2O	± 14 kPa (±2 psi) of O_2 reading	10 L/min	4 L/min

6. If required, adjust the O_2 and Air regulators to meet the above specifications. The N_2O regulator is not adjustable; replace if out of range.

   Note: The adjustment screws for these regulators are self-locking.
7. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
8. Perform the Flow Control Tests (Section 3.4).

5.3 Flowmeter Needle Valve Calibration

You need to calibrate a needle valve:

- if you install a new one,
- if minimum and maximum flows are not within specifications.

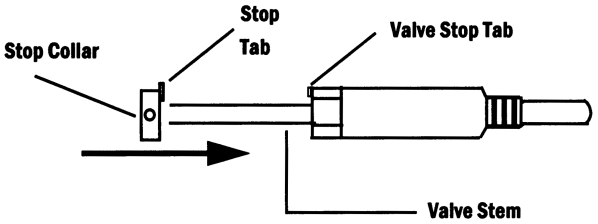
5.3.1 O_2 Needle Valve Calibration (Minimum Flow)

⚠ **CAUTION:** Do not force the needle valve against the seat. Overtightening the valve can cause the minimum flow setting to drift out of specifications.

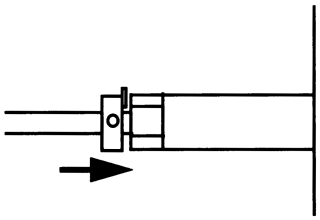
1. Set the system switch to Standby.
2. Remove the flowmeter panel shield (Section 9.7.1).

   Note: If adjusting an existing needle valve,

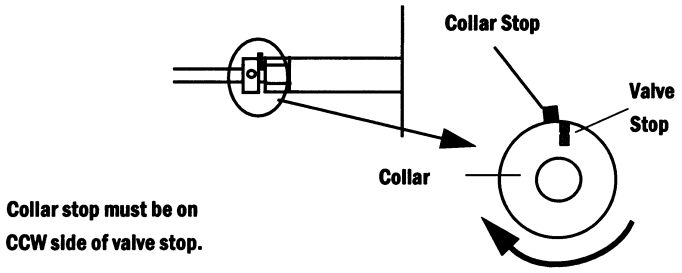
   - remove the N_2O and O_2 knob and sprocket assemblies (on machines with O_2 only flowhead, remove the O_2 knob),
   - and loosen the O_2 stop collar setscrews.
3. Slide a stop collar onto the valve stem with the stop tab toward the valve. Do not tighten setscrews.



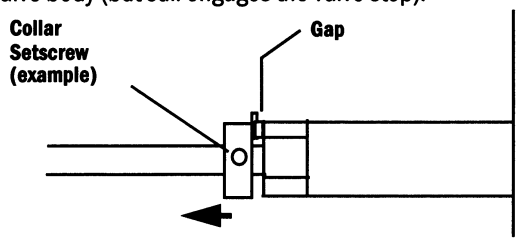
4. Set the system switch to On.
5. Adjust the O_2 needle valve to maintain a flow of
   - 50 ±25 mL/min for dual tube flowmeters.
   - 200 ±25 mL.min for single tube flowmeters.
6. Push the stop collar against the valve body.



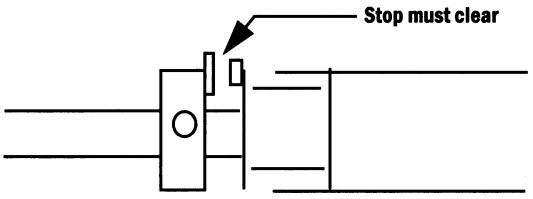
7. Turn the collar clockwise until the collar stop tab contacts the minimum stop tab on the valve body. *Do not turn the valve stem.*



8. Carefully pull the collar back so there is a slight gap between collar and the valve body (but still engages the valve stop).



9. Tighten the collar setscrews. Start with the one opposite the tab if possible.
10. Turn the valve stem counterclockwise at least one revolution to make sure the collar tab clears the valve stop.



If the stop does not clear:

a. Turn the valve stem back to minimum position.
b. Loosen the collar setscrews.
c. Repeat steps 6 through 9.

11. Turn the valve stem clockwise to the minimum stop.
12. Verify that the flow is within the
    - 50 ±25 mL/min range for dual tube flowmeters.
    - 200 ±25 mL/min range for single tube flowmeters.
13. Calibrate the Link proportioning system (Section 5.4)
    (on machines with O_2 only flowhead, replace and set the knob so that at minimum flow the label text is horizontal; replace the flowmeter shield).

5.3.2 N_2O Needle Valve Calibration (Minimum Flow)

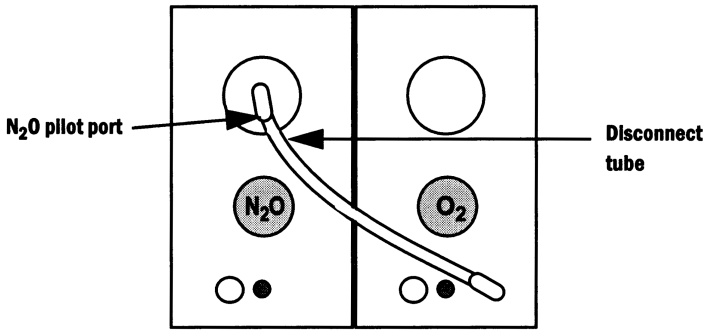
⚠ WARNING You must be in a well ventilated room or use a gas evacuation device at this time. Anesthetic vapors exhausted into the room air can be harmful to your health.

⚠ CAUTION: Do not force the needle valve against the seat. Overtightening the valve can cause the minimum flow setting to drift out of specifications.

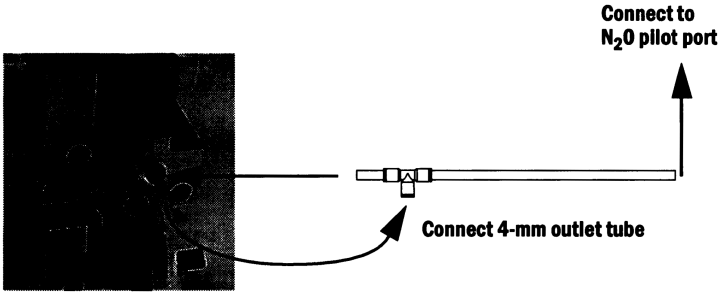
1. Disconnect all pipeline supplies and close all cylinder valves.
2. Remove the upper rear panel.

   Note: If adjusting an existing needle valve,

   - remove the N_2O and O_2 knob and sprocket assemblies,
   - and loosen the O_2 stop collar setscrews.
3. Remove the flowmeter panel shield (Section 9.7.1).
4. Disconnect the tube from the pilot port on the N_2O regulator.

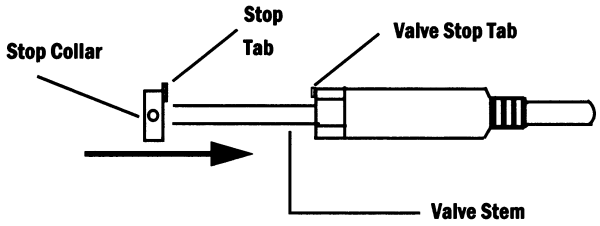


5. Disconnect the 4-mm outlet tube from the back of the N_2O pipeline manifold.



6. Using a 4-mm tube/tee fixture (see Service Tools - Section 10.1.1), connect a tube (tee end) to the N_2O supply outlet at the back of the pipeline manifold. Connect the outlet tube to the open connection on the tee connector of the fixture. Connect the other end of the fixture to the N_2O pilot port at the front of the flowhead. This setup supplies pilot pressure to the N_2O balancing regulator during the minimum stop calibration.

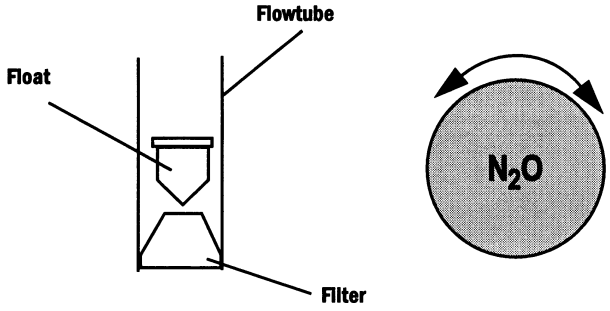
7. Slide a stop collar onto the valve stem with the stop tab toward the valve. Do not tighten setscrews.



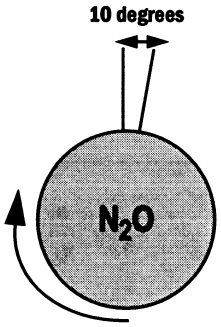
8. Connect either an N_2O pipeline or cylinder supply.
9. Slowly open the N_2O cylinder valve.

   Important: Do not connect the O_2 pipeline or open the O_2 cylinder valve.

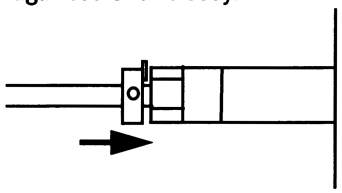
10. Adjust the needle valve until the float is nearly touching the filter, but not quite.



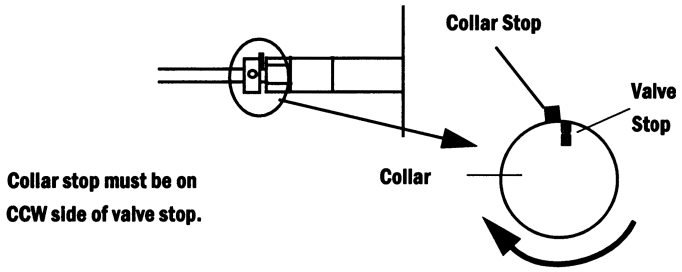
11. Disconnect the tubing from the inlet of the vaporizer manifold (closest to flowhead).
12. If the machine has an Air option, bleed down the air supply. Air can inflate the bubble (next step) if it is not shut off.
13. Apply a small amount of leak detection fluid (Snoop) to the end of the tube to form a bubble.
14. Turn the valve stem clockwise until the bubble no longer inflates. Do not turn more than 10 degrees clockwise past this point.



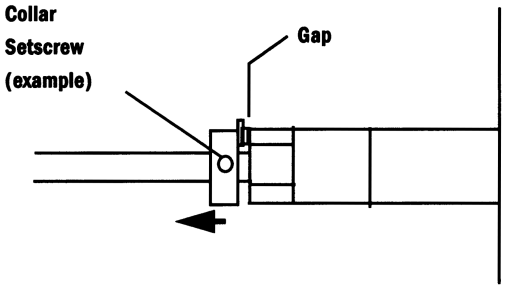
15. Push the stop collar against the valve body.



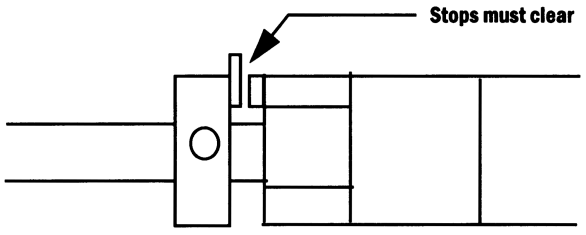
16. Turn the collar clockwise until the collar stop tab contacts the minimum stop tab on the valve body. *Do not turn the valve stem*.



17. Carefully pull the collar back so there is a slight gap between collar and the valve body (but still engages the valve stop).



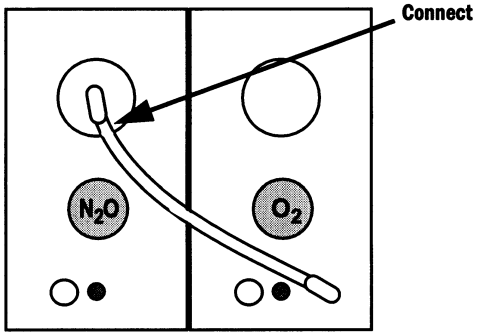
18. Tighten the collar setscrews. Start with the one opposite the tab if possible.
19. Turn the valve stem counterclockwise at least one revolution to make sure the collar tab clears the valve stop.



If the stops do not clear:

a. Turn the valve stem back to minimum position.
b. Loosen the collar setscrews.
c. Repeat steps 14 through17.

20. Turn the valve clockwise to the minimum stop.
21. Verify there is no flow at the end of the tube.
22. Thoroughly clean the end of the nylon tube and reconnect it to the vaporizer manifold inlet.
23. After calibrating minimum flow for N_2O:
    a. Close the cylinder valve and use the needle valve to bleed the remaining gas.
    b. Remove the test fixture connecting the N_2O gas supply to pressure balance regulator pilot port.
    c. Reconnect the pilot tube to the N_2O pilot port. Pull on the tubing to ensure it is locked into the fitting.



    d. Reconnect the outlet tube to the N_2O pipeline supply manifold.
24. Calibrate the Link proportioning system (Section 5.4).

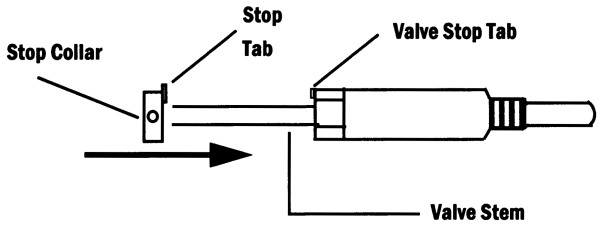
5.3.3 Air Needle Valve Calibration (Minimum Flow)

⚠ **CAUTION:** Do not force the needle valve against the seat. Overtightening the valve can cause the minimum flow setting to drift out of specifications.

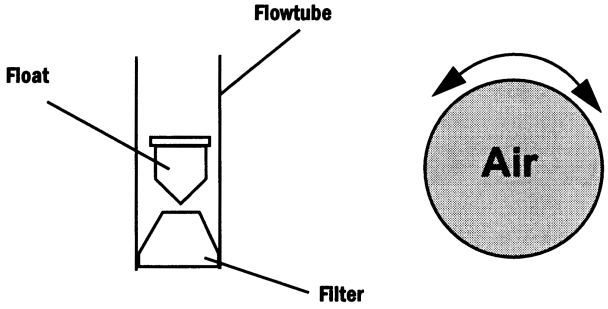
1. Set the system switch to Standby.
2. Disconnect all pipeline hoses and close all cylinder valves except for air.
3. Remove the flowmeter panel shield (Section 9.7.1).
4. Remove the upper rear panel.

   Note: If adjusting an existing needle valve,

   - remove the Air knob,
   - and loosen the Air stop collar setscrews.
5. Slide a stop collar onto the valve stem with the stop tab toward the valve. Do not tighten setscrews.

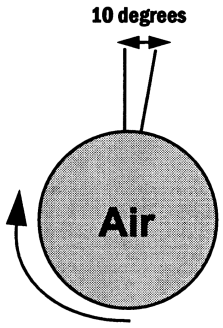


6. Set the system switch to On.
7. Adjust the needle valve until the float is nearly touching the filter, but not quite.

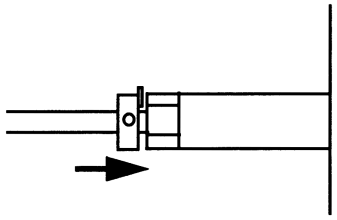


8. Disconnect the tubing from the inlet to the vaporizer manifold (left end of manifold).
9. Apply a small amount of leak detection fluid (Snoop) to the end of the tube to form a bubble.

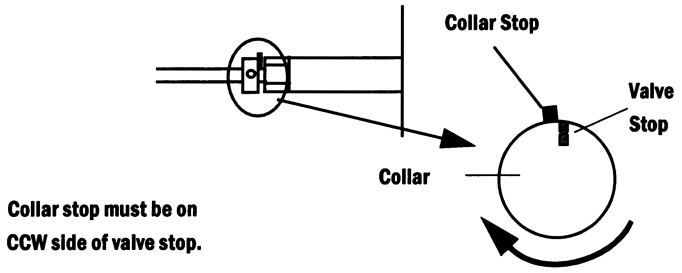
10. Turn the needle valve clockwise until the bubble no longer inflates. Do not turn more than 10 degrees clockwise past this point.



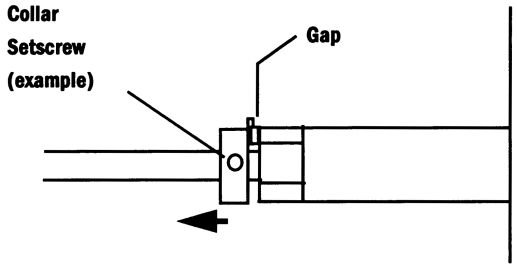
11. Push the stop collar against the valve body.



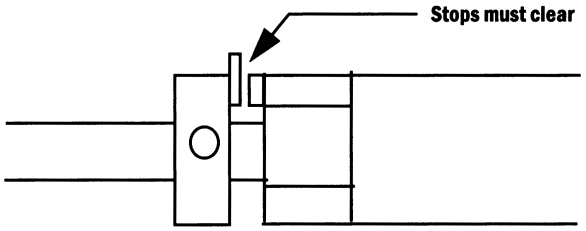
12. Turn the collar clockwise until the collar stop tab contacts the minimum stop tab on the valve body. ***Do not turn the valve stem.***



13. Carefully pull the collar back so there is a slight gap between collar and the valve body (but still engages the valve stop).



14. Tighten the collar setscrews. Start with the one opposite the tab if possible.
15. Turn the valve stem counterclockwise at least one revolution to make sure the collar tab clears the valve stop.



If stops do not clear:

a. Turn the valve stem back to minimum position.
b. Loosen the collar setscrews.
c. Repeat steps 11 through 14.

16. Turn the valve stem clockwise to the minimum stop.
17. Verify there is no flow at the end of the tube.
18. Thoroughly clean the end of the nylon tube and reconnect it to the vaporizer manifold inlet.
19. Set the knob so that at minimum flow the label text is horizontal and the knob is on an even plane (front to back) with the N_2O and O_2 knobs.
20. Replace the flowmeter panel shield and the rear panel.

5.4 Link system calibration

Before you start, make sure that:

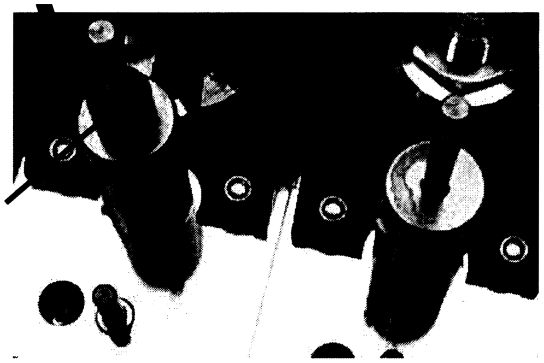
- All parts are correctly installed.
- Stops on needle valves are set correctly.
- The machine meets leak check requirements.
- Confirm that the O_2 sensor measures 21% in room air and 100% in pure O_2. If not, calibrate the O_2 sensor.

Note: All illustrations in this section show ANSI flowmeter module positions. The order is reversed on ISO machines.

⚠ WARNING You must be in a well ventilated room or use a gas evacuation device at this time. Anesthetic vapors exhausted into the room air can be harmful to your health.

1. Set the system switch to Standby.
2. Remove the flowmeter panel shield (Section 9.7.1).
3. Put the plastic spacer on the N_2O needle valve spindle.
4. Turn the O_2 and the N_2O needle valves clockwise to their minimum stop position.

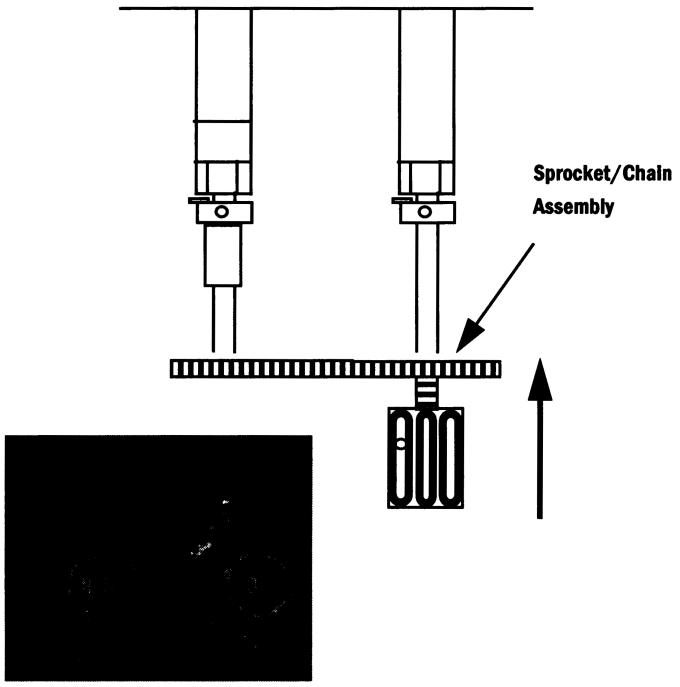
Spacer



5. Put the chain onto the O_2 knob/sprocket assembly and the N_2O sprocket.

   Note: The N_2O sprocket set screws should be away from the valve.

6. Install the chain and sprockets onto the needle valve stems as an assembly. Press the O_2 knob/sprocket against the O_2 minimum stop collar.

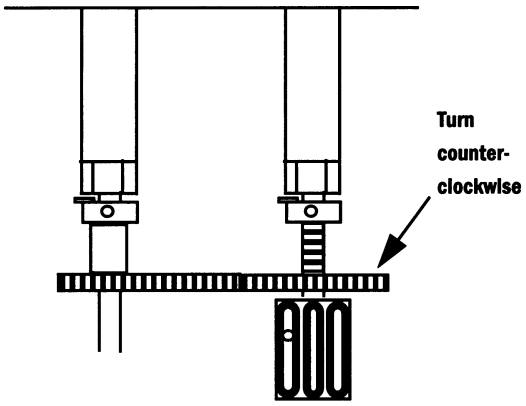


7. Tighten the setscrews in the O_2 knob. Do not tighten the N_2O sprocket setscrews.

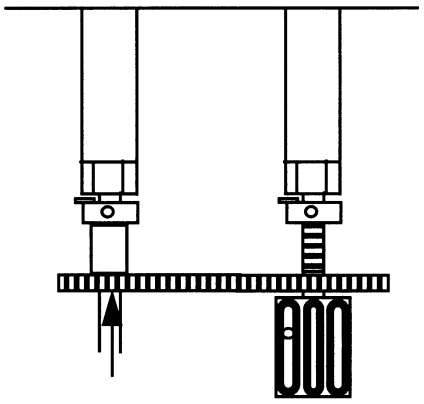
   Note: If O_2 label is on the knob, turn the knob so that the identification label is horizontal before tightening the setscrews.

8. Turn on the O_2 and the N_2O gas supplies (pipeline or cylinder).
9. Set the system switch to On.
10. Adjust the needle valves:
    - **O_2 needle valve:** 200 ±10 mL/min.
    - **N_2O needle valve:** 600 ±25 mL/min.

11. Turn the sprocket on the O_2 knob sprocket assembly counterclockwise until it stops against the tab on the O_2 knob. Do not allow the N_2O or O_2 valve stems to rotate.

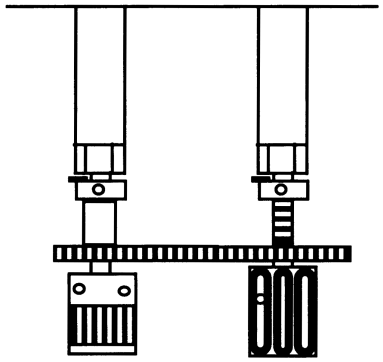


12. Push the N_2O sprocket against the plastic spacer.



13. Holding the O_2 knob, rotate the N_2O sprocket counterclockwise until all slack is removed from the chain.
14. Lightly tighten both N_2O sprocket setscrews.
15. Turn the N_2O needle valve clockwise to the minimum stop position.

16. Install the N_2O knob. Turn the knob so that the identification label is horizontal before tightening the setscrews.



17. Turn the N_2O needle valve counterclockwise, and check that the oxygen flow increases as N_2O flow increases.
18. Turn the O_2 needle valve clockwise, and check that the N_2O flow decreases as O_2 decreases.
19. Check the proportioning system concentration (increasing N_2O flow). Observe the following precautions:
    - Start with both valves at the minimum setting.
    - Adjust only the N_2O needle valve.
    - Increase the N_2O flow as specified in the table below and make sure the O_2 concentration is in the allowed range.

    Note: Allow the O_2 monitor to stabilize. At the lower flows, the O_2 monitor may take up to 90 seconds to stabilize.

    - If you overshoot a setting, turn the O_2 needle valve clockwise until the N_2O flow decreases to the previous setting before continuing the test.

Set the N_2O flow (L/min)	Measured O_2
0.8	22% to 29%
1	22% to 29%
2	22% to 29%
6	22% to 29%
9	22% to 29%

20. Check the proportioning system concentration (decreasing O_2 flow). Observe the following precautions:

    - Turn the N_2O needle valve to the maximum setting.
    - Adjust only the O_2 needle valve.
    - Decrease the O_2 flow as specified in the table and make sure the O_2 concentration is in the allowed range.

    Note: Allow the O_2 monitor to stabilize. At the lower flows, the O_2 monitor may take up to 90 seconds to stabilize.

    - If you overshoot a setting, turn the N_2O needle valve counterclockwise until the O_2 flow increases to the previous setting before continuing the test.

Set the O_2 flow (L/min)	Measured O_2
3	22% to 29%
2	22% to 29%
1	22% to 29%
0.3	22% to 29%

    If both tests meet the criteria, calibration is complete (go to the next step). If either test fails to meet the criteria, return to step 10 and adjust N_2O to a lower or higher setting.

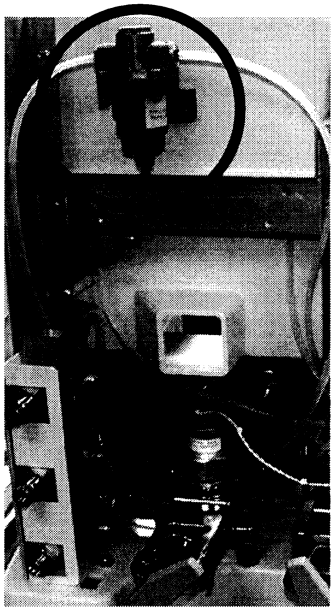
If:	Then:
Concentration Low	Decrease N_2O
Concentration High	Increase N_2O

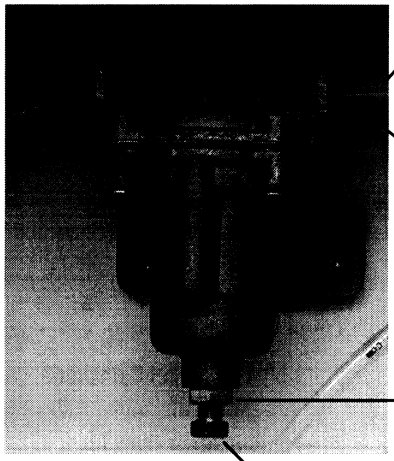
    Note: Adjusting the regulator pressure is not recommended. It has little effect on proportioning. If you have difficulty proportioning the system, you may need to replace either or both needle valves.

21. Tighten N_2O sprocket setscrews.
22. Set the system switch to Standby.
23. Turn off the O_2 and the N_2O gas supplies.
24. Check that all setscrews are tight.
25. Adjust all needle valves to minimum stop position.
26. Install flowmeter panel shield.

5.5 O_2 Flush Regulator

1. Bleed all gas pressure for the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the upper rear panel (Section 9.2).
4. Remove the O_2 Flush Regulator output tubing. Attach a 6-mm tee and a test device to the open port.





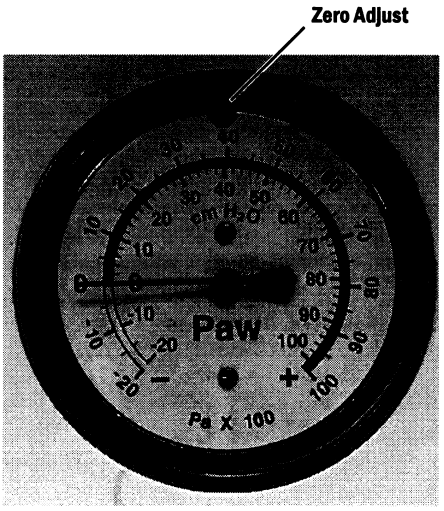
5. Connect an O_2 pipeline supply or slowly open the O_2 cylinder valve.
6. Push the flush button just enough to achieve a slight flow or open the auxiliary flowmeter if equipped with this option. Read the pressure shown on the test device.

   The pressure should be 241 ±7 kPa (35 ±1.0 psi).
7. If adjustment is required:
   a. Loosen the adjustment screw's jam nut.
   b. Adjust the regulator (in small steps) to the above specification.
   c. Tighten the jam nut.
   d. Verify the reading.
8. Disconnect the pipeline supply or close the cylinder valve.
9. Bleed gas pressure by pushing the flush button; then, disconnect the tee and test device.
10. Reattach the output tubing to the regulator.
11. Install the rear panel.

5.6 Airway pressure gauge

5.6.1 Zero the pressure gauge

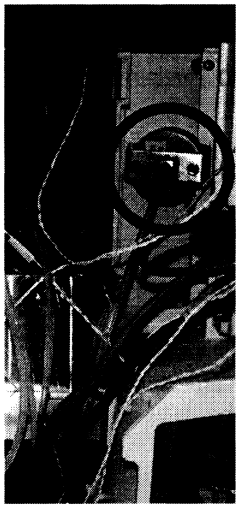
1. Attach a patient circuit to the Breathing System. Leave the patient end open.
2. Set the Bag/Vent switch to Bag.
3. Adjust the APL valve to maximum.
4. Remove the lens from the pressure gauge:
   - Apply a slight pressure with your thumb and finger tips around the outer edge of the lens.
   - Turn the lens counterclockwise to remove it.
5. Adjust the pressure gauge to zero.
6. Plug the patient circuit.
7. Press and release the O_2 flush button to sweep the needle across the pressure gauge.
8. Remove the plug from the patient circuit to relieve the pressure in the circuit and recheck the zero setting of the pressure gauge.
9. If required, repeat zero and span procedure.
10. Replace the lens cover.



5.6.2 Checking the pressure gauge accuracy

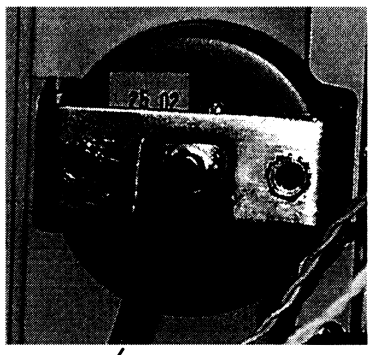
The accuracy of the airway pressure gauge can be checked by using the following:

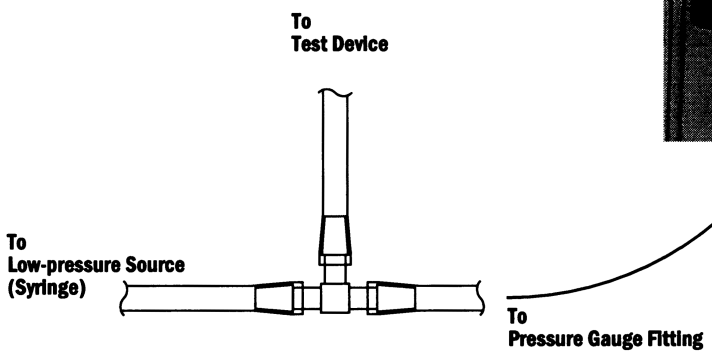
- a low-pressure test device (digital manometer or test gauge) with an accuracy of ±2% of reading,
- a low-pressure supply source (typically a syringe),
- and an airway pressure gauge test adapter.



1. Ensure that the pressure gauge is zeroed (Section 5.6.1).
2. Remove the upper rear panel.
3. Remove the existing tube from the back of the pressure gauge and connect the test adapter tube directly to the gauge.
4. Connect a low-pressure supply source (syringe) to one of the open tubes of the test adapter.
5. Connect a low-pressure test device to the remaining open tube of the test adapter.
6. Adjust the pressure source to the following pressures as read on the airway pressure gauge. The test device gauge should read within the values indicated.

Airway Pressure Gauge	Test Device
0 cm H_2O	0 ±1 cm H_2O
40 cm H_2O	40 ±2 cm H_2O
-5 cm H_2O	-5 ±2 cm H_2O





6 Installation and Maintenance

In this section

This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the Aespire Anesthesia Machine – including the ventilator – operates to specifications.

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⚠ **WARNINGS**

Do not perform testing or maintenance on the Aespire Anesthesia Machine while it is being used on a patient. Possible injury can result.

Items can be contaminated due to infectious patients. Wear sterile rubber gloves. Contamination can spread to you and others.

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

6.1 Aespire 7100 Installation Checklist

Serial Number:	Date: (YY/MM/DD) / /
Hospital:	Performed by:

- ☐ 1. Unpack and assemble the Aespire 7100 System.
- ☐ 2. Reconfigure the sample gas return line as required (*Section 9.12*).
- ☐ 3. If necessary, access the ***Service Mode - Language*** menu (*Section 4.6*) and select the correct language.
- 4. Access the ***Service Mode - System Configuration*** menu (*Section 4.8*). Perform the following steps:
  - ☐ a. Enter the site ***Altitude*** in increments of 100 meters.
  - ☐ b. Select the correct ventilator ***Drive Gas*** (O_2 or Air).
  - ☐ c. Make sure that ***Heliox Mode*** is set to "Disabled". Aespire machines cannot be configured to deliver Heliox.
  - ☐ d. Select the desired ***VE Alarm Limits*** (Automatic or User Adjustable).
  - ☐ e. ***Enable - Disable*** installed optional monitoring and ventilation features as desired by the customer (O_2 Monitoring, Volume Monitoring, Volume Compensation, Pressure Mode, Pressure Waveform).
- 5. Access the ***Service Mode - Calibrations*** menu (*Section 4.9*). Perform the following calibrations:

Note: At installation, the *Airway Sensor Span* calibration is not required before the *PEEP Valve Calibration* unless it shows up in the "*Service Calibration Required*" screen.

  - ☐ a. ***O2 Calibrations*** (*Section 4.9.1*).
  - ☐ b. ***Zero Flow and Airway Sensors*** (*Section 4.9.2*).
  - ☐ c. ***Adjust Drive Gas Regulator*** (*Section 4.9.3*).
  - ☐ d. ***PEEP Valve Calibration*** (*Section 4.9.5*).
  - ☐ e. ***Inspiratory Valve Calibration*** (*Section 4.9.6*).
  - ☐ f. ***Pressure Sensitivity*** (*Section 4.9.7*).
- ☐ 6. Exit the Service Mode and go to Normal Operations. Verify the "Service Calibration ⚠" alarm message is not present in the normal system display.

7. Complete the System Checkout by performing the following steps:

- ☐ a. Inspect the system (*Section 3.2*).
- ☐ b. Pipeline and cylinder tests (*Section 3.3*).
- ☐ c. Flow control tests (*Section 3.4*).
- ☐ d. Pressure relief tests (*Section 3.5*).
- ☐ e. O_2 supply alarm tests (*Section 3.6*).
- ☐ f. Flush flow tests (*Section 3.7*).
- ☐ g. Vaporizer back pressure test (*Section 3.8*).
- ☐ h. Low-pressure leak test (*Section 3.9*).
- ☐ i. Alarm tests (*Section 3.10*).
- ☐ j. Breathing systems tests (*Section 3.11*).
- ☐ k. Auxiliary O2 flowmeter tests, if equipped with this option (*Section 3.12*).
- ☐ l. Integrated suction regulator tests, if equipped with this option (*Section 3.13*).
- ☐ m. Power failure test (*Section 3.14*).
- ☐ n. Electrical safety tests (*Section 3.15*).

6.2 Aespire 7100 Planned Maintenance

Serial Number:	Date: (YY/MM/DD) / /
Hospital:	Performed by:
☐ 12 months ☐ 24 month	☐ _____

This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the Aespire 7100 anesthesia machine – including the ventilator – operates to specifications.

6.2.1 Every twelve (12) months

Perform the following steps every 12 months.

For details, refer to the sections listed.

Parts Replacement

☐ Replace the vaporizer port o-rings (*Section 9.8.1*)
(Kit Stock Number 1102-3016-000)

Machine Checks and Tests

Refer to the Aespire User's Reference Manual, Part 2.
Perform the following steps:

☐ 1. User maintenance listed below. Including disassembly, inspection, cleaning and parts replacement as required (*Section 3 and Section 2*).

- AGSS Maintenance:
  Empty any condensate from the reservoir (disposable item).
  Inspect air brake for occlusion.
  Inspect, clean or replace filter on active AGSS.
- Breathing Circuit Maintenance
- Bellows Assembly Maintenance
- Bellows Assembly Tests
- O_2 Sensor Calibration
- Flow Sensor Calibration

Refer to listed sections in this manual.
Perform the following steps:

☐ 1. MOPV pressure relief valve test (Section 6.3)

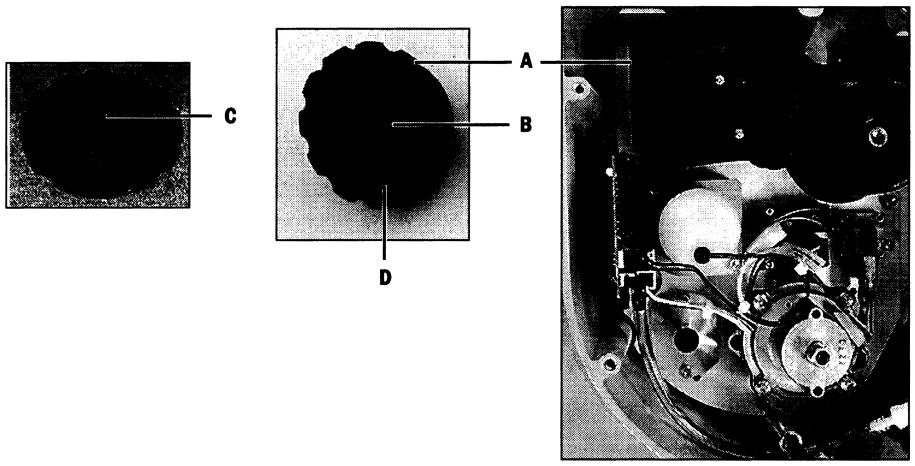
- ☐ 2. From the Ventilator Service Mode menu, perform the following:
  - Display Discrete I/O Signals. Verify proper operation of all switches. (*Section 4.10.2*)
  - Display Error Log. If any error codes have been logged follow the appropriate troubleshooting procedures. Clear the error log. (*Section 4.5*)
  - Adjust Drive Gas Regulator (*Section 4.9.3*)
  - Airway Sensor Span (*Section 4.9.4*)
  - PEEP Valve Calibration (*Section 4.9.5*)
  - Inspiratory Valve Calibration (*Section 4.9.6*)
  - Pressure Sensitivity (*Section 4.9.7*)
- ☐ 3. Inspect the system (*Section 3.2*)
- ☐ 4. Pipeline and cylinder tests (*Section 3.3*)
- ☐ 5. Flow control and pressure relief tests (*Section 3.4*)
- ☐ 6. Vaporizer back pressure test (*Section 3.8*)
- ☐ 7. Low-pressure leak test (*Section 3.9*)
- ☐ 8. Airway pressure gauge accuracy check (*Section 5.6.2*)
- ☐ 9. Alarm tests (*Section 3.10*)
- ☐ 10. Breathing systems tests (*Section 3.11*)
- ☐ 11. Auxiliary O_2 flowmeter tests, if equipped with option (*Section 6.5*)
- ☐ 12. Integrated suction regulator tests, if equipped with option (*Section 6.6*)
- ☐ 13. Power failure test (*Section 3.14*)
- ☐ 14. Electrical safety tests (*Section 3.15*)

6.2.2 Every twenty-four (24) months

In addition to the 12-month requirements, replace the following parts every 24 months. All machine and ventilator parts should be replaced before performing the checks, tests, and calibrations.

- ☐ 1. Replace the internal backup battery (*Section 7.2.3*) (Stock Number 1504-3505-000).
- ☐ 2. Replace the free breathing flapper valve (*Section 6.2*) (Stock Number 0211-1454-100).
- ☐ 3. Replace the free breathing valve o-ring (*Section 6.2*) (Stock Number 1503-3208-000).

6.3 Free breathing valve maintenance



Refer to Section 9.23 to access the Pneumatic Vent Engine.

1. Unscrew the valve seat (**A**) from the side of the interface manifold.
2. Inspect the flapper (**B**) and valve seat for nicks, debris and cleanliness.

To replace the flapper valve

3. If necessary, clean the new flapper valve with alcohol.
4. Pull the tail (**C**) of the new free breathing valve flapper through the center of the valve seat until it locks in place.
5. Trim the tail flush with outside surface of the valve seat (refer to the removed flapper).
6. Replace the O-ring (**D**). Lubricate with a thin film of Krytox.
7. Hand screw the assembly into the interface manifold.
8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure (refer to the respective User's Reference manual).

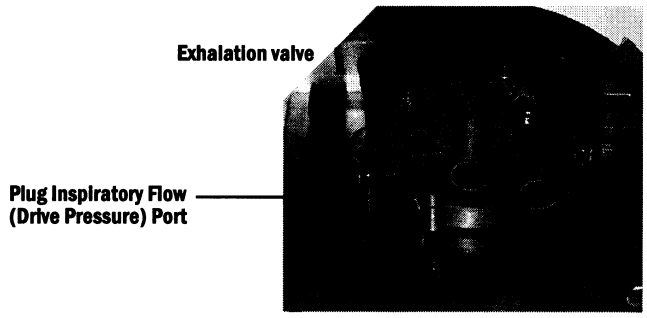
6.4 MOPV pressure relief valve test

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

6.4.1 Test setup

1. Remove the ABS breathing system.
2. Plug the inspiratory flow (drive pressure) port of the exhalation valve with a stopper.



6.4.2 Test procedure

1. Set the system switch to On and enter the Service Mode.
2. Select "Diagnostic Tests/Tools"; select "Valves - Test Tool".
3. Select "Set Inspiratory Valve" and activate a flow of 10 L/min.
4. Carefully listen for the MOPV relief weight to be relieving and "popping off" from its seat (a purring sound). This indicates the valve is functioning correctly.
5. Set the system switch to Standby.
6. Remove the stopper from the inspiratory flow port.
7. Reassemble the system.
8. Perform the Preoperative Checkout Procedure (refer to the respective User's Reference manual).

6.5 Auxiliary O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Rotate the flow control clockwise to shut off the flow.

Flow Accuracy Test

Note: To check flow accuracy, be sure that the flow test device is capable of measuring 0 to 15 L/min with an accuracy of ±2% of reading.

1. Connect the flowmeter outlet to the flow test device.
2. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
3. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting L/min	**Lower Limit L/min**	**Upper Limit L/min**
1	0.52	1.48
3	2.56	3.44
5	4.60	5.40
10	9.70	10.30
maximum (valve fully open)	12.00	-------

4. Rotate the flow control clockwise to shut off the flow.
5. Close the O_2 cylinder valve or disconnect the O_2 pipeline.

6.6 Integrated Suction Regulator tests

Note There are two types of integrated suction systems for the Aespire 7100 anesthesia machine:

- Continuous Vacuum Regulator, Three-Mode, Pipeline Vacuum
- Continuous Vacuum Regulator, Three-Mode, Venturi Derived Vacuum

For Pipeline Vacuum systems,
a vacuum source of at least 500 mm Hg (67 kPa or 20 in Hg) is required for testing. The supply open flow must be a minimum of 50 L/min.

For Venturi Derived Vacuum systems,
an O_2 or Air source of at least 282 kPa (41 psi) is required for testing.

Gauge Accuracy The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of tolerance.

Note To check gauge accuracy, be sure that the test gauge is capable of measuring 0 to 550 mm Hg with an accuracy of ±1% of reading.

1. Connect the suction patient port to the test gauge.
2. Turn the mode selector switch to I (ON).
3. Ensure that the vacuum test gauge is in agreement with the suction vacuum gauge ± 38 mm Hg/5 kPa at the following test points.

Test points

Suction vacuum gauge	**Test gauge tolerance**
100 mm Hg (13.3 kPa)	62–138 mm Hg (8.3–18.4 kPa)
300 mm Hg (40 kPa)	262–338 mm Hg (35–45 kPa)
500 mm Hg (66.7 kPa)	462-538 mm Hg (61.6–71.7) kPa)

Flow Test **Note:** To check flow accuracy, be sure that the flow test device is capable of measuring 0–30 L/min.

1. Connect the patient port of the suction regulator to the flow test device.
2. Rotate the suction control knob fully clockwise (increase).
3. Turn the mode selector switch to I (ON) and verify that the flow rate is:
   - at least 20 L/min.
4. Disconnect the test flowmeter.

(Tests continue on next page.)

Regulation Test

1. Turn the mode selector switch to I (ON).
2. Occlude the patient port of the suction regulator.
3. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
4. Open and close the patient port several times.
5. With the patient port occluded, the gauge should return to 100 mm Hg/13 kPa within a tolerance of ± 10 mm Hg/1.3 kPa.

Vacuum Bleed Test

1. Occlude the patient port of the suction regulator.
2. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
3. Turn the mode selector switch to O (OFF) and observe the gauge needle. It must return to the zero range bracket or stop pin within 10 seconds.

Vacuum Leak Test

1. Turn the mode selector switch to O (OFF).
2. Rotate the suction control knob a minimum of two full turns in the clockwise direction (increase suction) to ensure its setting is not at the off position.
3. Occlude the patient port of the suction regulator.
4. Observe the suction gauge, the needle should not move.
5. Rotate the suction control knob fully counterclockwise to ensure its setting is at the fully off position.
6. Turn the mode selector switch to I (ON).
7. Observe the suction gauge, the needle should not move.

7 Troubleshooting

In this section

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7.1 General Troubleshooting

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

Problem	Possible Cause	Action
High Pressure Leak	Pipeline leak	Use a leak detector or Snoop to check for source of leak. Repair or replace defective parts.
	O_2 flush valve	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace valve if defective.
	System switch	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace switch if defective.
	Cylinder not installed properly	Make sure cylinder is correctly aligned. Verify that tee handles are tight.
	Cylinder gauges	Use a leak detector or Snoop to check for source of leak. Replace gauge if defective.
	Cylinder gaskets	Use a leak detector or Snoop to check for source of leak. Replace gasket if defective.
	Relief valves	Use a leak detector or Snoop to check for source of leak. Replace valve if defective.
Low Pressure Leak (with vaporizer mounted)	Vaporizer not installed properly	Reseat vaporizer if not installed properly. Have vaporizer serviced at vaporizer center if vaporizer leaks.
	Missing or damaged o-ring on vaporizer manifold	Check condition of o-ring. Replace if missing or damaged.
	Loose fill port	Check fill port. Tighten if loose.

Problem	Possible Cause	Action
Low Pressure Leak (with or without vaporizer)	Leaking port valve on vaporizer manifold	Use the Vaporizer Manifold Valve Tester to check for leak. See Section 9.8.2 for instructions. If test fails, tighten, repair, or replace as needed.
	Leak at flowmeter head	If vaporizer manifold passed previous tests: Remove tubing from input side of head and occlude port. Perform leak test. If test fails: • Check for damaged o-rings between flowmeter modules. Replace as needed. • Check for damaged o-rings at top and bottom of flow tubes. Replace as needed. • Check for cracked flow tube. Replace as needed.
		If secondary regulator leaks, replace the complete module.
		Note: An alternate method is to pressurize the system and use a leak detector or Snoop to check for source of leak.
	Leaking relief valve on vaporizer manifold	Remove relief valve. Occlude opening. Perform leak test. If test passes, replace valve.
	Leaking flush valve	Attach pressure measuring device on CGO. Replace valve if device shows increased pressure.
	Leaking system switch	Attach pressure measuring device on CGO. Replace switch if device shows increased pressure.
Bellows leak	Pop-off valve diaphragm not sealing properly	Disassemble pop-off valve; inspect and clean seats; reseat; reassemble.
	Bellows mounting rim loose	Remove rim and pop-off valve diaphragm; reseat diaphragm; snap rim (2) into place.
	Bellows improperly mounted or has a hole or tear	Check that only the last bellows convolute is mounted to the rim and that the ring roll is in the groove under the rim. Inspect the bellows for damage; replace.
Breathing System Leak	Absorber canister not installed properly	Install canister properly.
	Damaged/missing canister o-ring	Check/replace o-ring.
Breathing System Leak (Intermittent)	ACGO O_2 sense check valve	Replace.
N_2O flow does not decrease with O_2 flow	Defective pilot regulator	Check pilot regulator. Replace if needed.
Unit displays low O_2 pressure with pipeline but not with cylinders	Low O_2 supply switch	Check switch. Calibrate or replace as appropriate.
Unable to begin mechanical ventilation	ABS not fully engaged	Remount ABS.
	No O_2 supply	Check O_2 supply.
	Defective Bag/Vent switch	Check Bag/Vent switch.

7.2 Breathing System Leak Test Guide

Note Always perform the low-pressure leak test (Section 3.9) on the machine before proceeding with these breathing system leak tests.

The procedure in Section 7.2.1 helps you isolate the leak: to Bag Mode components, to Vent Mode components, or to components that are common to both modes.

- If you have a similar leak in both the bag mode and the ventilator mode, you must consider the Flow Sensor Module, the Circuit Module, the Absorber Canister area, and the bulkhead components (including CGO tubing). Carefully inspect the circuit module for damaged seals or misassembly, and the seating of the O_2 sensor.
- If you have a larger leak in one area than the other (Vent or Bag), the leak is most likely NOT in the Flow Sensor Module, the Circuit Module, the Absorber Canister area, or the bulkhead ports.

Follow the troubleshooting flowcharts in Section 7.2.2 to determine the best sequence of tests for locating a breathing system leak.

The procedures in Section 7.2.3 test specific components of the breathing system for leaks.

⚠ WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

7.2.1 Breathing system leak test

This test checks for leaks in Vent Mode and Bag Mode components. It is part of the overall checkout procedure, Section 3.11 "Breathing system tests." It is repeated here for testing convenience.

⚠ WARNING

Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.

1. Verify that AGSS is operating. For systems that have a flow indicator on the side, make sure that the flow indicator shows a flow in the green (normal) region.
2. Zero the pressure gauge (Section 5.6.1).

Check Valves

3. Make sure that the check valves on the breathing circuit module work correctly:
   a. The Inspiratory check valve rises during inspiration and falls at the start of expiration.
   b. The Expiratory check valve rises during expiration and falls at the start of inspiration.

Ventilator Bellows

4. Ventilator bellows test:
   a. Set the system switch to Standby.
   b. Set the Bag/Vent switch to Ventilator.
   c. Set all flow controls to minimum.
   d. Close the breathing circuit at the patient connection. Use the test plug located on the side of the ABS.
   e. Push the O_2 flush button to fill the bellows.
   f. The pressure must not increase to more than 15 cm H_2O on the pressure gauge.
   g. If the bellows falls more than 100 mL/min (top of indicator), it has a leak.

Service Mode Tests

5. Enter the Service Mode: Push and hold the adjustment knob on the ventilator's display and set the system switch to On.
   a. Select and confirm "Service Modes."
   b. Follow the menu structure outline below to reach the adjustment for the inspiratory flow valve. Select and confirm at each step.
      - "Diagnostics Tests/Tools"
      - "Breathing System Leak Test"
   c. Follow the instructions on the screen.
   d. The leak rate should be less than 200 mL/min.
      For machines with a single-tube O_2 flowmeter, the pressure reading should reach 30 cm H_2O at minimum flows greater than 200 mL/min.

Bag Circuit

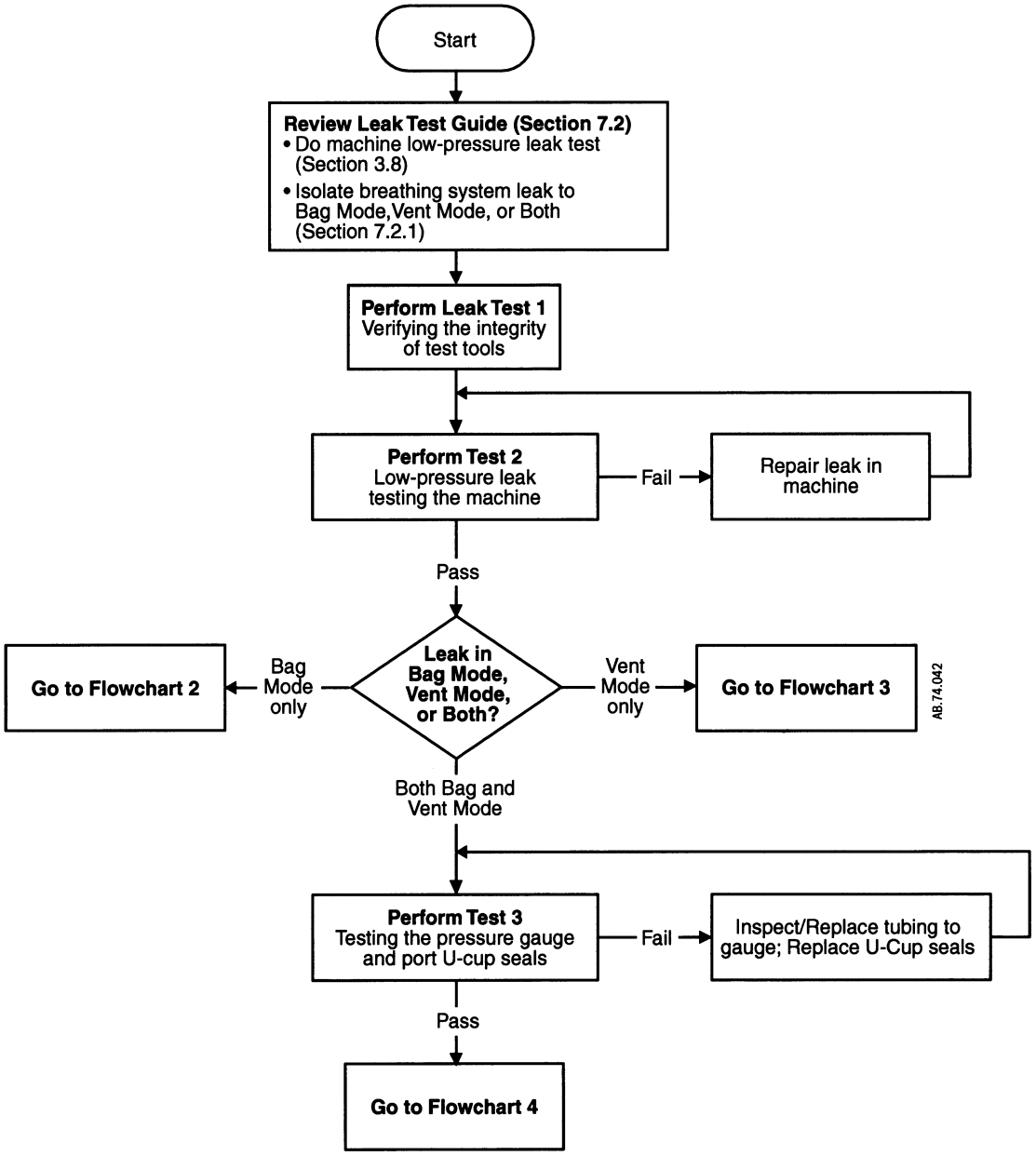
6. Test the Bag circuit for leaks:
   a. Set the system switch to On.
   b. Set the Bag/Ventilator switch to Bag.
   c. Plug the Bag port (use your hand or the approved test plug).
   d. Close the APL valve (70 cm H_2O).
   e. Set the O_2 flow to 0.25 L/min.
   f. Close the patient connection (using a hand or test plug on the side of the breathing system) and pressurize the bag circuit with the O_2 flush button to approximately 30 cm H_2O.
   g. Release the flush button. The pressure must not decrease. A pressure decrease large enough to see on the gauge indicates an unacceptable leak.

APL Valve

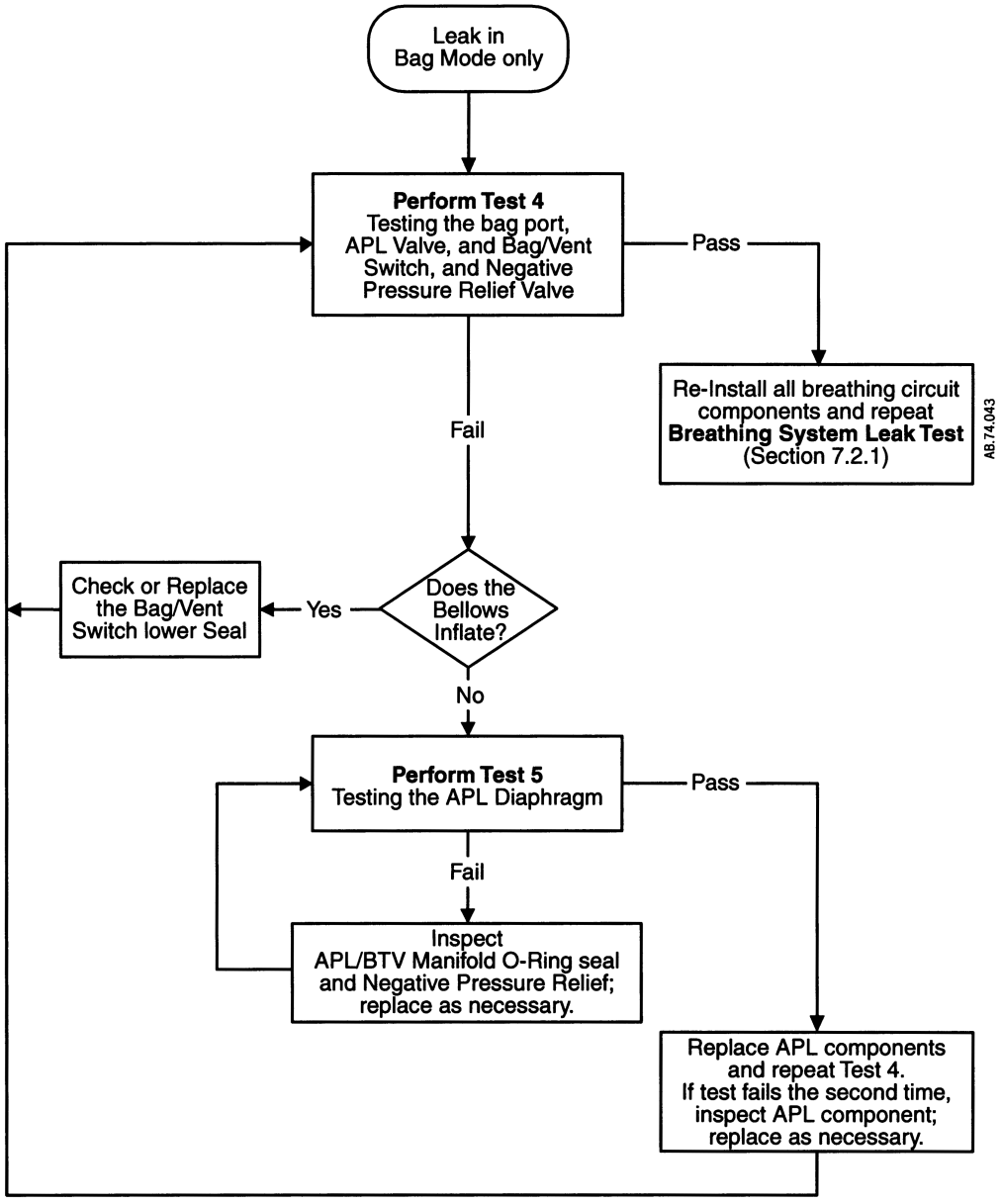
7. Test the APL valve:
   a. Fully close the APL valve (70 cm H_2O).
   b. Set the total fresh gas flow to approximately 3 L/min and make sure that the value on the inspiratory pressure gauge does not exceed 85 cm H_2O. Some pressure fluctuation is normal.
   c. Fully open the APL valve (to the MIN position).
   d. Set O_2 flow to 3 L/min. Turn any other gases off.
   e. Make sure that the value on the inspiratory pressure gauge is less than approximately 5 cm H_2O.
   f. Push the O_2 flush button. Make sure that the value on the inspiratory pressure gauge stays less than 10 cm H_2O.
   g. Set the O_2 flow to minimum and make sure that the value on the inspiratory pressure gauge does not decrease below 0 cm H_2O.
8. Remove your hand or the test plug from the patient connection.
9. Set the System switch to Standby.

⚠ WARNING Make sure that there are no test plugs or other objects caught in the breathing system.

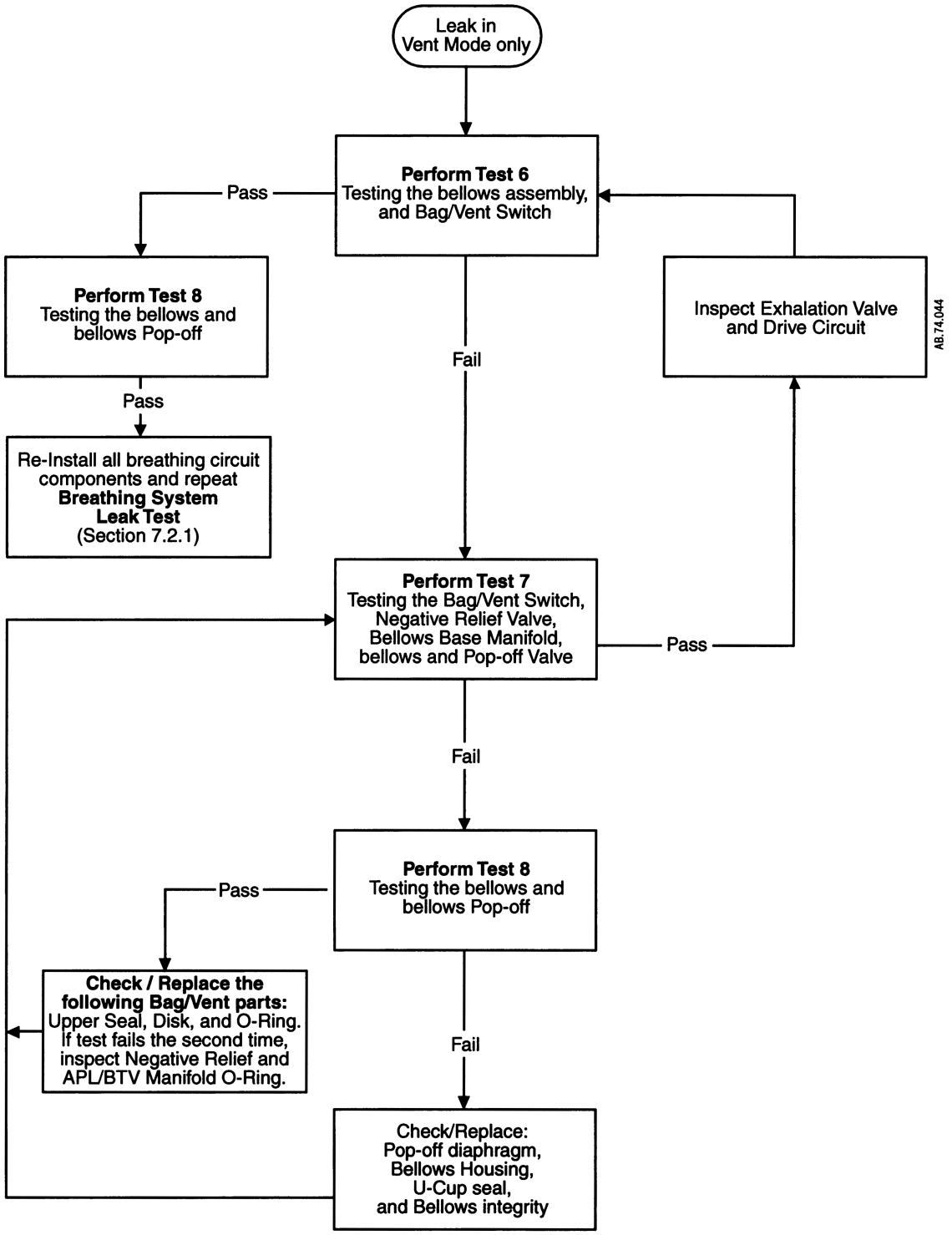
7.2.2 Breathing System Troubleshooting Flowcharts



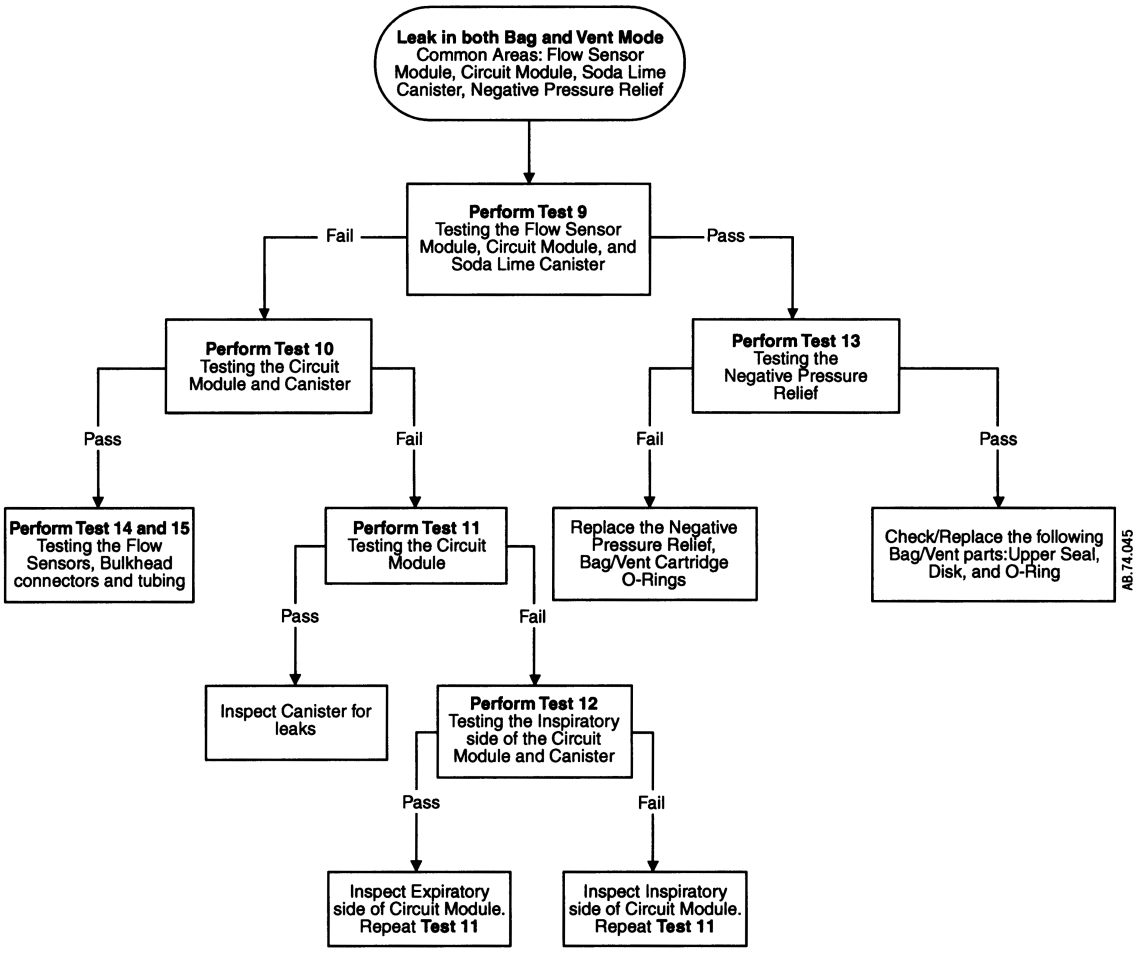
Flowchart **1**


Leak in
Bag Mode only
Perform Test 4
Testing the bag port,
APL Valve, and Bag/Vent
Switch, and Negative
Pressure Relief Valve
Pass
Re-Install all breathing circuit
components and repeat
Breathing System Leak Test
(Section 7.2.1)
A8.74.043
Fail
Does the
Bellows
Inflate?
Yes
Check or Replace
the Bag/Vent
Switch lower Seal
No
Perform Test 5
Testing the APL Diaphragm
Pass
Fail
Inspect
APL/BTV Manifold O-Ring seal
and Negative Pressure Relief;
replace as necessary.
Replace APL components
and repeat Test 4.
If test fails the second time,
inspect APL component;
replace as necessary.

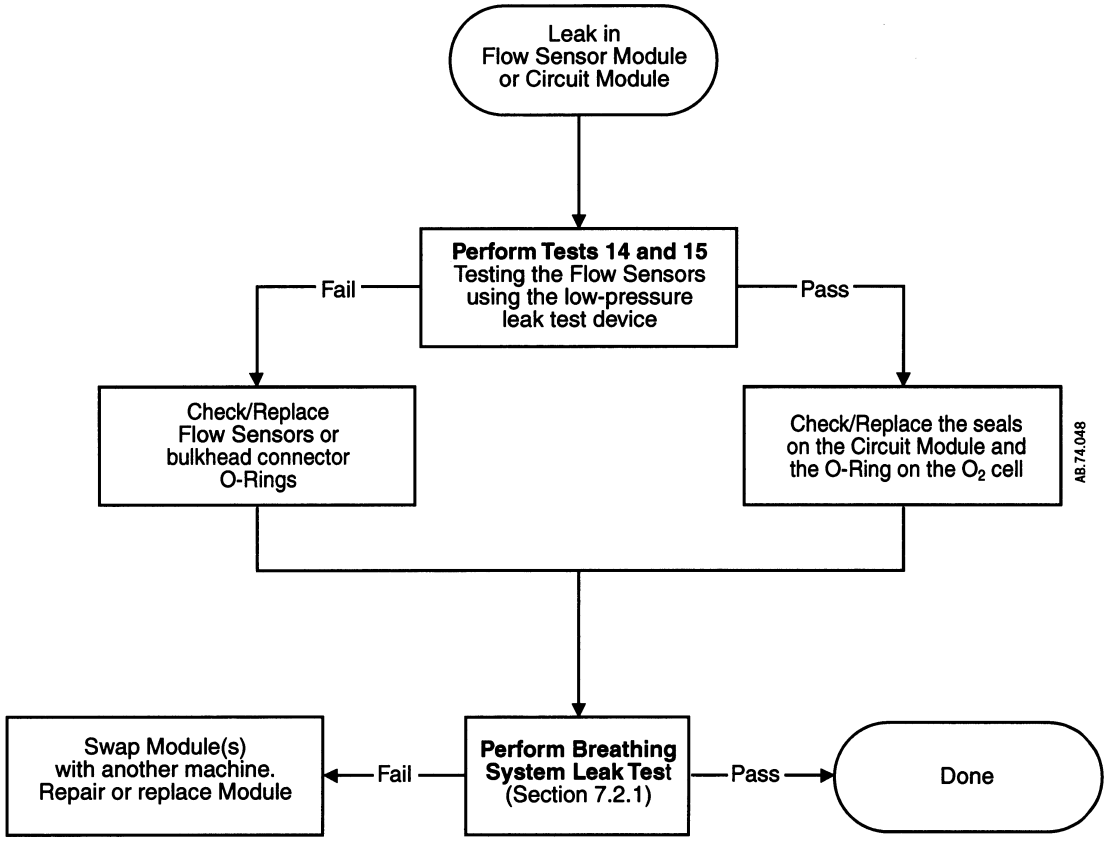
Flowchart 2


Leak in
Vent Mode only
Perform Test 6
Testing the bellows assembly,
and Bag/Vent Switch
Pass
Perform Test 8
Testing the bellows and
bellows Pop-off
Pass
Re-Install all breathing circuit
components and repeat
Breathing System
Leak Test
(Section 7.2.1)
Fail
Inspect Exhalation Valve
and Drive Circuit
AB.74.044
Perform Test 7
Testing the Bag/Vent Switch,
Negative Relief Valve,
Bellows Base Manifold,
bellows and Pop-off Valve
Pass
Fail
Perform Test 8
Testing the bellows and
bellows Pop-off
Pass
Check / Replace the
following Bag/Vent parts:
Upper Seal, Disk, and O-Ring.
If test fails the second time,
inspect Negative Relief and
APL/BTV Manifold O-Ring.
Fail
Check/Replace:
Pop-off diaphragm,
Bellows Housing,
U-Cup seal,
and Bellows integrity

Flowchart 3


Leak in both Bag and Vent Mode
Common Areas: Flow Sensor Module, Circuit Module, Soda Lime Canister, Negative Pressure Relief
Perform Test 9
Testing the Flow Sensor Module, Circuit Module, and Soda Lime Canister
Fail
Pass
Perform Test 10
Testing the Circuit Module and Canister
Perform Test 13
Testing the Negative Pressure Relief
Pass
Fail
Fail
Pass
Perform Test 14 and 15
Testing the Flow Sensors, Bulkhead connectors and tubing
Perform Test 11
Testing the Circuit Module
Replace the Negative Pressure Relief, Bag/Vent Cartridge O-Rings
Check/Replace the following Bag/Vent parts:Upper Seal, Disk, and O-Ring
A8.74.045
Pass
Fail
Inspect Canister for leaks
Perform Test 12
Testing the Inspiratory side of the Circuit Module and Canister
Pass
Fail
Inspect Expiratory side of Circuit Module. Repeat Test 11
Inspect Inspiratory side of Circuit Module. Repeat Test 11

Flowchart 4


Leak in
Flow Sensor Module
or Circuit Module
Perform Tests 14 and 15
Testing the Flow Sensors
using the low-pressure
leak test device
Fail
Pass
Check/Replace
Flow Sensors or
bulkhead connector
O-Rings
Check/Replace the seals
on the Circuit Module and
the O-Ring on the O_2 cell
AB.74.048
Swap Module(s)
with another machine.
Repair or replace Module
Fail
Perform Breathing
System Leak Test
(Section 7.2.1)
Pass
Done

Flowchart 5

7.2.3 Leak Isolation Tests

The previous flowcharts refer you to the following tests.

These tests require the use of the Low Pressure Leak Test Device and the Leak Test Tool Kit (refer to Section 10.1.3, "Test Tools".

The Leak Test Tool Kit includes:

- the Machine Test Tool
- the Circuit Test Tool
- and various Test Plugs

When performing these tests, ensure that the ACGO selector switch is set to the ABS position.

Test 1: Verifying the integrity of the test tools. 7-13

Test 2: Low-pressure leak testing the machine 7-14

Test 3: Testing the airway pressure gauge, and Port 1 and Port 3 u-cup seals 7-15

Test 4: Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve 7-16

Test 5: Testing the APL diaphragm 7-17

Test 6: Testing the bellows module and the Bag/Vent switch 7-18

Test 7: Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch. 7-19

Test 8: Testing the bellows assembly 7-20

Test 9: Testing the flow sensor module, the circuit module, and the soda lime canister 7-21

Test 10: Testing the circuit module and the canister 7-22

Test 11: Testing the circuit module 7-22

Test 12: Testing the inspiratory side of the circuit module 7-23

Test 13: Testing the negative pressure relief valve. 7-24

Test 14: Testing the flow sensors only. 7-25

Test 15: Testing a flow sensor including the Ventilator Monitoring Assembly and interfacing components 7-26

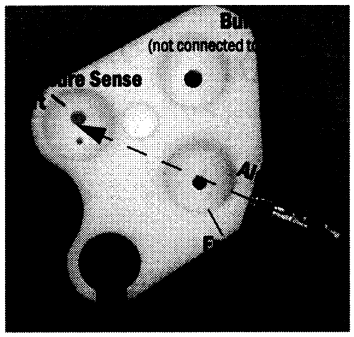
⚠ WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

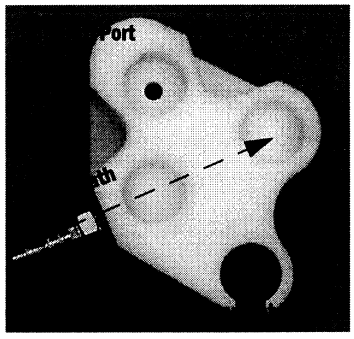
⚠ CAUTION Do not use O_2 Flush for leak isolation tests. Do not leave pressurized systems unattended. High pressure and equipment damage may result.

Test 1 Verifying the integrity of the test tools

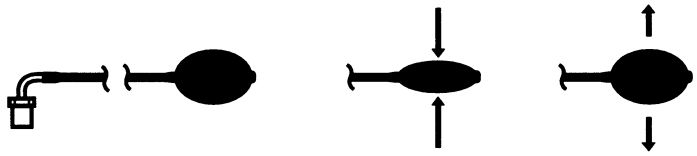
Machine Test Tool
Front View



Back View



1. Verify integrity of low-pressure leak test device.
   - Put your hand on the inlet of the leak test device. Push hard for a good seal.
   - Squeeze the bulb to remove all air from the bulb.
   - If the bulb completely inflates in less than 60 seconds, replace the leak test device.



2. Attach the low-pressure leak test device to the Machine Test Tool.
3. Plug the two pressure orifices.
4. Repeatedly squeeze and release the hand bulb until it remains collapsed.
5. If the bulb inflates in less than 30 seconds, locate and correct the leak.

Test 2 Low-pressure leak testing the machine

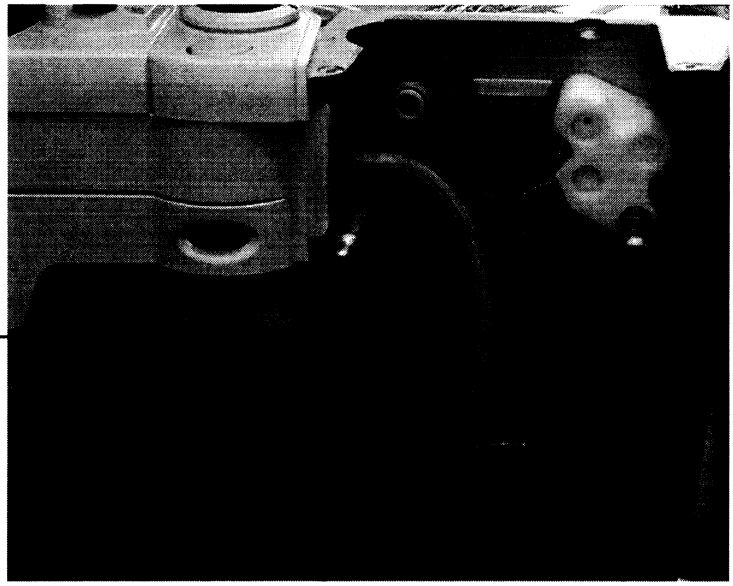
1. Remove the breathing system from the machine.
2. Attach the Machine Test Tool (using only the Thru Port) and the low-pressure leak test device to **Port 3** of the breathing system interface as shown above.

   Note: To prevent damage to the airway pressure gauge, ensure that the gauge port (**Port 1**) is not connected to the Test Tool.
3. Set the ACGO selector switch to ABS.
4. Set the system switch to Standby.
5. Turn off all vaporizers.
6. Open the flow controls one and a half turns counterclockwise.
7. Compress and release the bulb until it is empty.
8. The vacuum causes the floats to move. This is usual. If the bulb completely inflates in 30 seconds or less, there is a leak in the low-pressure circuit.

Test 3 Testing the airway pressure gauge, and Port 1 and Port 3 u-cup seals

1. Attach the Machine Test Tool to the breathing system interface ports (using the alignment post) as shown above.
2. Turn all of the flow controls fully clockwise (minimum flow).
3. Set the system switch to On.
4. Occlude the tapered plug.
   - At minimum flow, the airway pressure gauge reading should increase.
   - If not, there is a leak in the tested circuit.

Test 4 Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve



1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Occlude the Bag Port connector.
3. Connect the Machine Test Tool to the interface ports as shown above.
4. Set the Bag /Vent switch to Bag and close the APL Valve (70 cm H_2O).
5. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

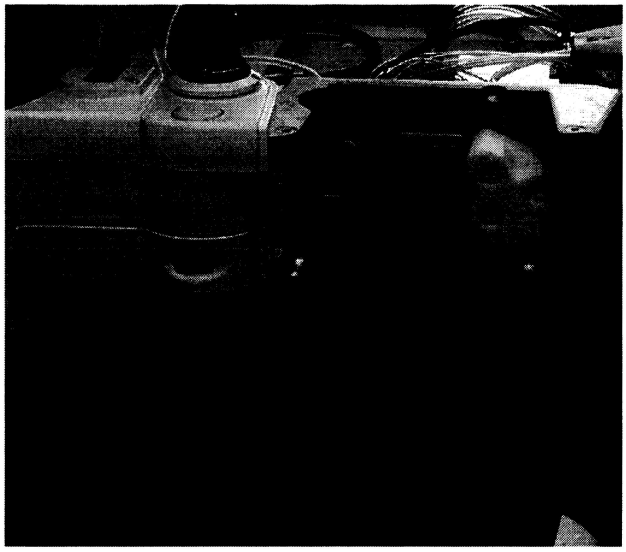
   Note: If the bellows rises, it indicates a leak in the Bag /Vent Switch.

Test 5 Testing the APL diaphragm

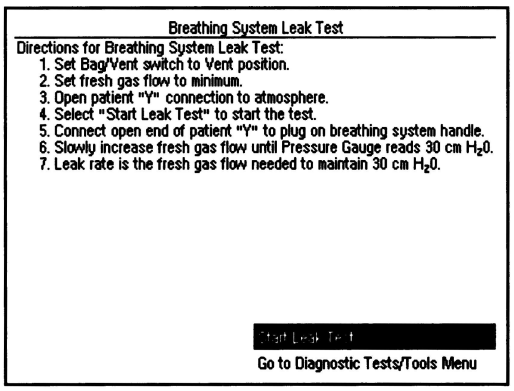
Note If required, set up the Machine Test Tool and breathing system as shown in Test 4.

1. Slide the Bellows Module away from the machine.
2. Remove the APL ramp and diaphragm.
3. Insert a Test Plug into the APL scavenging port, as shown above.
4. Slide the Bellows Module partially back onto the machine casting.
5. Ensure that the Bag Port is plugged and that the Bag/Vent switch is set to Bag.
6. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - Leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

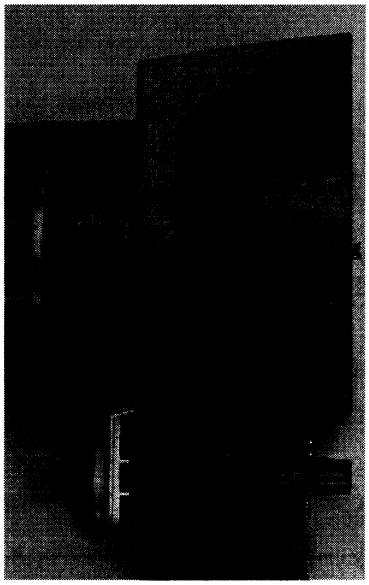
Test 6 Testing the bellows module and the Bag/Vent switch



1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Enter the Service Mode: Push and hold the adjustment knob on the ventilator's display and set the system switch to On.
   a. Select and confirm "Service Modes."
   b. Follow the menu structure outline below to reach the adjustment for the inspiratory flow valve. Select and confirm at each step.
   - "Diagnostics Tests/Tools"
   - "Breathing System Leak Test"
3. Follow the instructions on the screen.
   - At step 5, connect the Machine Test Tool to the interface ports as shown above, instead. Continue with steps 6 and 7 on the screen.
   - The leak rate should be less than 200 mL/min.



Test 7 Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch



1. Separate the Bellows Module from the Circuit Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.

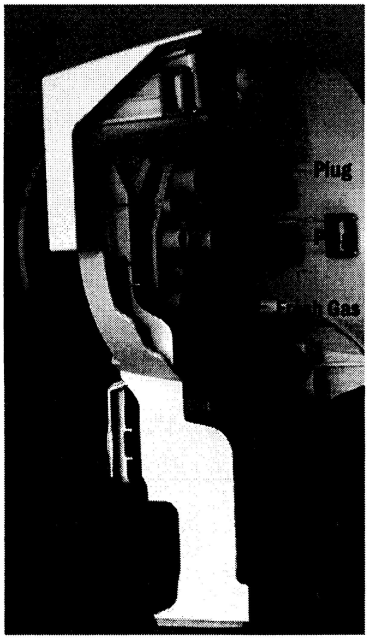
   Note: Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Set Bag/Vent switch to Vent.
4. Position the bellows upright with the bellows collapsed.
5. Connect the Machine Test Tool to the interface ports as shown above.
6. Slowly increase the O_2 flow to achieve 30 cm H_2O.

   Note: The bellows will rise until the pressure equalizes.

   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

Test 8 Testing the bellows assembly

Note If required, set up the Machine Test Tool and breathing system as shown in Test 7.



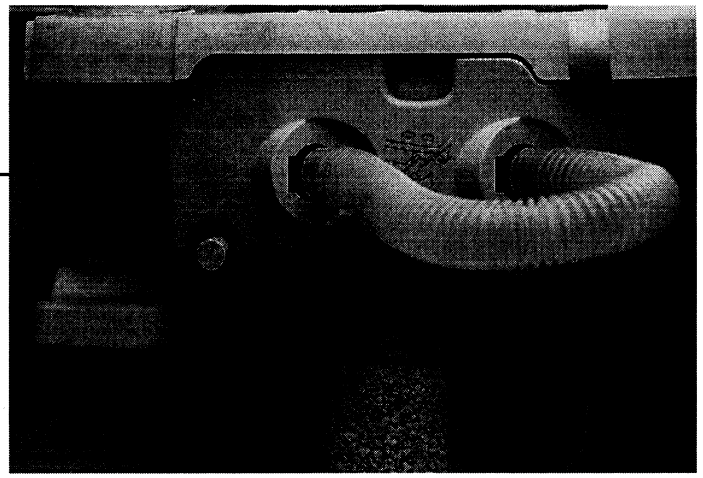
1. Remove the bellows base manifold from the Bellows Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.

   Note: Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Connect the tapered plug of the Machine Test Tool to the bellows base inlet as shown to the left.
4. Position the bellows upright with the bellows collapsed.
5. Slowly increase the O_2 flow to achieve 30 cm H_2O.

   Note: The bellows will rise until the pressure equalizes.

   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

Test 9 Testing the flow sensor module, the circuit module, and the soda lime canister

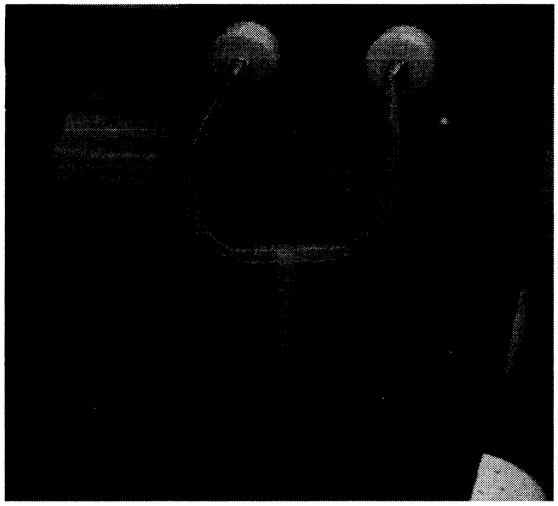


1. Separate the Bellows Module from the Circuit Module and re-install the Circuit/Flow Sensor Module.
2. Connect short tubing between the inhalation and exhalation ports of the breathing system.
3. Insert an appropriate test plug in the outlet port of the Circuit Module.
4. Enter the Service Mode: Push and hold the adjustment knob on the ventilator's display and set the system switch to On.
   a. Select and confirm "Service Modes."
   b. Follow the menu structure outline below to reach the adjustment for the inspiratory flow valve. Select and confirm at each step.
      - "Diagnostics Tests/Tools"
      - "Display A/D Channels"
   c. Record the Inspiratory and Expiratory Flow actual values.

      Note: The Inspiratory and Expiratory Flow actual values should be near zero.
5. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.
6. Observe the Inspiratory and Expiratory Flow actual values. The values should be near zero, as previously recorded in step 4.

   Note: If one channel indicates flow, see "Inaccurate Volume Ventilation Troubleshooting" in the 7100 Ventilator Service Manual.
7. Release Pressure.

Test 10 Testing the circuit module and the canister



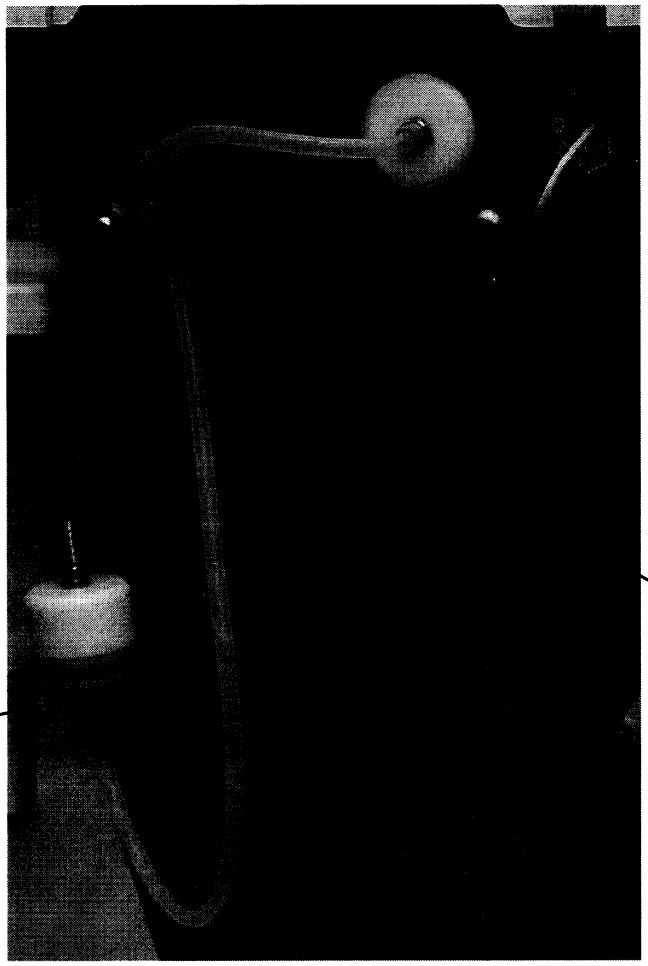
1. Remove the Flow Sensor module.
2. Connect the Circuit Test Tool to the Circuit Module as shown above.
3. Slowly increase the O_2 flow to achieve 30cmH_2O. The leak rate is equal to the flow required to maintain 30 cmH_2O.
   - The leak rate should be less than 200 mL/min.

Test 11 Testing the circuit module

Note: If required, set up the machine as in Test 10.

1. Remove the Soda Lime Canister.
2. Using appropriate Test Plugs, plug the three canister ports in the Circuit Module as shown above.
3. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

Test 12 Testing the inspiratory side of the circuit module

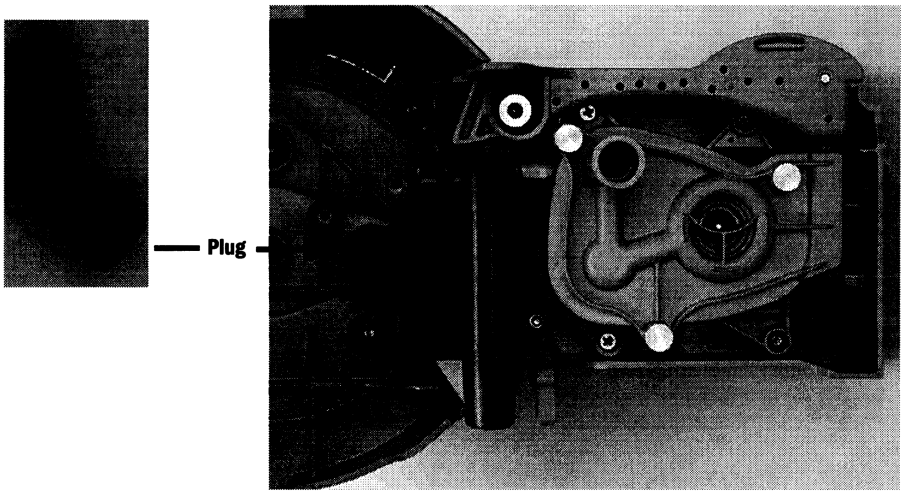


Note: If required, set up the machine as in Test 10 and 11.

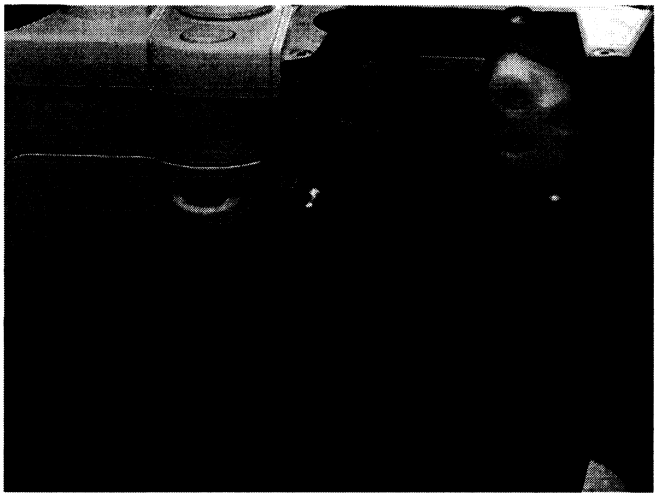
1. Connect the Circuit Test Tool to the Circuit Module as shown above.
2. Insert an appropriate test plug in the inspiratory outlet to the canister as shown above.
3. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

Test 13 Testing the negative pressure relief valve

1. Separate the Bellows Module from the Circuit Module.
2. Remove the Bellows Interface Manifold.
3. Insert test plug (recessed end) into the rear Bag/Vent switch port as shown.



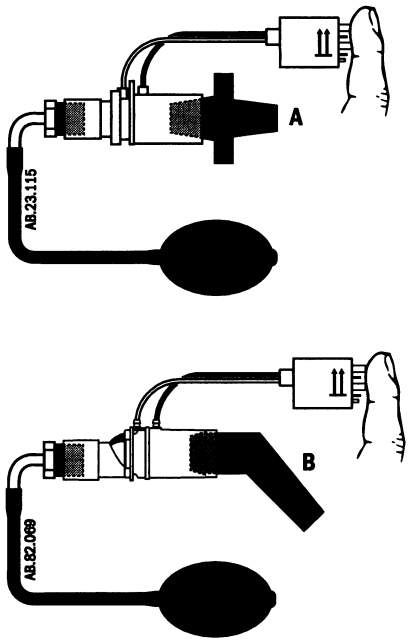
4. Install the Bellows Module.
5. Connect the Machine Test Tool to the interface ports and the Bellows Module as shown above.



6. Set the Bag/Vent Switch to Vent.
7. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 200 mL/min.

Test 14 Testing the flow sensors only

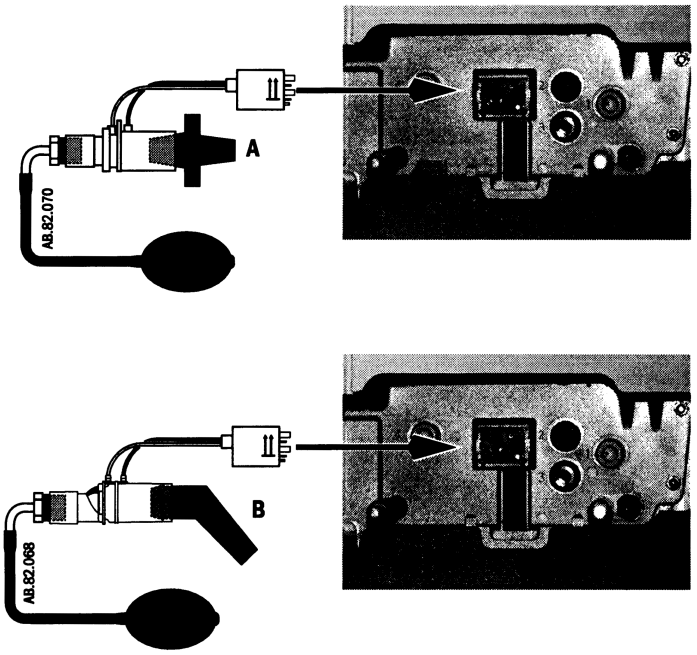
Note: *To ensure a air-tight seal, use the corresponding plug as illustrated for the original flow sensor (**A**) or the new, moisture resistant (offset) flow sensor (**B**).*



1. Remove the Flow Sensor Module.
2. Plug each Flow Sensor as shown above.
3. Connect the low-pressure leak test device to the open end of the Flow Sensor.
4. Block the connector end of the Flow Sensor with your hand.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak in the flow sensor.
7. If there are no leaks in the flow sensors, go to Test 15.

Test 15 Testing a flow sensor including the Ventilator Monitoring Assembly and interfacing components

Note: *To ensure a air-tight seal, use the corresponding plug as illustrated for the original flow sensor (**A**) or the new, moisture resistant (offset) flow sensor (**B**).*



1. Remove Flow Sensors from the Flow Sensor Module.
2. Attach the Flow Sensor to the bulkhead connector.
3. Plug each Flow Sensor as shown.
4. Connect the low-pressure leak test device to the open end of the Flow Sensor.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak. The leak may be through the connector o-rings, in the internal tubing, or in the Transducer on the VMB.

Troubleshooting instructions

Some ventilator problems may not generate any ventilator messages, even though the ventilator may not be functioning correctly:

- Refer to Section 7.3, "*Troubleshooting guide*."

For ventilator problems that result in an Alarm or Error message:

- Refer to Section 7.4, "*Alarm and Error messages*."

To help isolate a problem:

- Refer to Section 7.5, "*Troubleshooting Flowcharts*."

7.3 Troubleshooting guide

Symptom	Probable cause	Action
• Continuous alarm sounds whenever system switch is turned On — **5V Fail Alarm**	1. Failure in power section of Control Board.	1. Replace Control Board.
The Control Board includes a hardware generated alarm that sounds continuously if the 5 volt supply fails.		

Symptom	Probable cause	Action
• **AC LED not lit** (Power cord plugged into live receptacle; AC Inlet circuit breaker On)	1. Blown fuses in Control Module's AC receptacle	1. Check/replace fuses.
	2. Universal power supply	2. Check power supply output (Section 2.7.2).
(The problem is most likely in the +6V supply or in the LED circuit.)	3. Front panel keyboard (LED is part of it)	3. Check ribbon cable connection; replace front panel keyboard.
	4. Control board	4. +6V-------R11------ to LED; replace Control Board.
The LED is powered by the +6V supply from the universal power supply. Turn system switch to On. If ventilator operates from the backup battery, check 1 and 2. If ventilator operates from line power, check 3 and 4.		

Symptom	Probable cause	Action
• **Nothing happens when System switch is turned On**	1. Cable from J11 of Control Board to SICB.	1. Check/jumper cable connection; replace cable.
	2. Cable from System Switch to SICB.	2. Check cable connection; replace cable.
(The problem is most likely somewhere between the system switch and the control board.)	3. Serial Isolation Connector Board (SICB)	3. Replace SICB.
Turning the system switch to On should pull the ***Rem_On*** signal low on the control board. The above actions verifies the integrity of the ***Rem_On*** signal path. First, jumper pins 8 and 15 of J11 on control board to verify that the control board itself is OK.		

Symptom	Probable cause	Action
• **No display** (System switch On; LED lit; Fan running) (The problem is most likely in the Control Module.)	1. Ribbon cable, control board to LCD display 2. LCD display 3. Control board	1. Check cable connection. 2. Replace LCD display. 3. Replace control board.
The lit LED indicates that AC power is getting to the power supply. The power supply is most likely OK since it's supplying the 6V (*VMAIN*) to power the LED and fan (and the rest of the circuitry).		

Symptom	Probable cause	Action
• **Fan doesn't run** (Everything else OK) (The problem is most likely the fan or control board.)	1. Fan harness 2. Fan 3. Control board	1. Ensure fan harness is plugged in. 2. Replace fan. 3. Replace control board.
Power for the fan (derived from *VBUS*) comes from the Power Section of the control board.		

Symptom	Probable cause	Action
• **No alarm audio** (Alarm messages OK) (The problem is most likely the speaker or control board.)	1. Speaker cable 2. Speaker 3. Control board	1. Ensure cable is plugged in. 2. Replace speaker. 4. Replace control board.
Power for the speaker comes from the Power Section of the control board. Drive for the speaker comes from the Digital Section of the control board.		

7.4 Alarm and Error messages

Alarm Message

Error Message

The Service Mode (refer to section 4) includes a log of the 20 most recent Alarm messages (not shaded) and Error messages (shaded) experienced by the ventilator system.

If a User Alarm persists after the recommended action has been performed, the message indicates the probable component and related circuit that needs repair. Use the Service Mode tests to isolate the fault. The items in the Service Repair column indicate the path from the named component to the control board.

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
12 Hour Test ⚠	User Alarm	System in use for more than 12 hours without a powerup self test.	At end of case, move the system switch from On to Standby to On.	
+12V Analog Out-of- Range	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
-12V Analog Out-of- Range	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
12V -10VA Test Out-of-Range	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Absorber Panel Open	User Alarm	The top panel on Aestiva is not completely closed. ABS on Aespire in not completely engaged.	Close the panel. Reinstall ABS.	If persists, check: • Panel switch • Harness to VMB • VMB • Cable to CB/J12
A/D Converter Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Apnea Alarm Standby	User Alarm	Normal condition after End Case, powerup, or ACGO change from On to Off.	Monitoring resumes after first breath (mechanical) or 2 breaths within 30 sec (non-mechanical).	
Apnea Alarm Off	User Alarm	The cardiac bypass option is selected (Alarm Settings menu).	Apnea alarms are turned off when this option is selected.	
Aux Gas Outlet On	User Alarm	The outlet selection switch is set to the auxiliary common gas outlet.	Connect the patient circuit to the auxiliary outlet. For mechanical ventilation or ventilation with monitoring, select the common gas outlet.	If persists, check: • ACGO switch • VMB • Cable to CB/J12

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Battery Charger Fail	User Alarm	The current in the battery charging circuit is too high.	System is operational, but may fail on battery if mains power is lost.	Replace: • Battery • Control Board
Battery Charging ⚠	User Alarm	Battery is not fully charged.	Leave the system plugged in to charge the battery. If power fails, the total backup time will be < 30 minutes.	If persists, replace: • Battery • Control Board
Battery Current High	User Alarm	Battery current > 6 amps for 10 seconds.	System is operational, but may fail on battery if mains power is lost.	If persists, replace: • Battery • Control Board
Battery Failure High	User Alarm	Battery voltage > 8 V for 10 seconds.	System is operational, but may fail on battery if mains power is lost.	If persists, replace: • Battery • Control Board
Battery Failure Low	User Alarm	The battery voltage is too low (< 2 V) to supply the system if power fails.	System is operational, but may fail on battery if mains power is lost. Leave the system plugged in to charge the battery.	If persists, replace: • Battery • Control Board
Cal Flow Sensors	User Alarm	The last flow sensor calibration failed.	Calibrate the flow sensors. Look for water in the flow sensor tubes and dry if necessary. Replace sensor if necessary.	This alarm message indicates that the last flow sensor's differential pressure transducer calibration failed. With the BTV switch in Bag, ensure sensors are removed until the "No Insp / No Exp flow Sensor" messages appear. If persists, replace: • VMB • Control Board
Calibrate O_2 Sensor	User Alarm	Calibration failure or O_2% >110%	Does the sensor measure 21% O_2 in room air? Replace sensor if necessary.	If persists, Check: • O_2 sensor cable • VMB • Cable to CB/J12
Canister Open	User Alarm	The canister release is open, causing a large leak (Aestiva only). (Closed by default in Aespire machine.)	Close the canister release.	If persists, check: • Canister switch • Harness to VMB • VMB • Cable to CB/J12

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Cardiac Bypass	User Alarm	The alarm limit settings are set for a patient on cardiac bypass. Apnea alarms are off.	Use the alarm limits menu to change this setting.	
Check Flw Sensors ⚠	User Alarm	System has detected an improper flow pattern in the breathing circuit.	Are the flow sensors correctly installed? Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken? Improper check valve operation? Inspect one-way valves. Replace flow sensor module with the spare. Check the condition of the flow sensor and its tubing.	
Circuit Leak Audio Off	User Alarm	Control setting on the Alarm Settings menu.	This message tells you that the audio alarm for circuit leaks was turned off.	
Connect O_2 Sensor	User Alarm	The O_2 sensor is not connected to the cable.	Connect the sensor.	If persists, Check: • O_2 sensor cable • VMB • Cable to CB/J12
CPU Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
CPU Internal Error	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Exp Flow Sensor Fail	User Alarm	System cannot read the calibration data stored in the sensor.	Operation continues with reduced accuracy. Replace the flow sensor.	
Exp Reverse Flow	User Alarm	Flow through the expiratory sensor during inspiration (for 6 breaths in a row).	Look at the check valves. Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken? Replace the expiratory check valve. Check the flow sensor condition.	
Flow Valve (DAC) Failure	Error Minimum Monitoring	Ventilator malfunction.	Ventilate manually. Monitoring is still available.	Replace: • Control Board.

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Flow Valve (Voltage) Failure	Error Minimum Monitoring	Ventilator malfunction.	Ventilate manually. Monitoring is still available.	Check/Replace: • Flow Valve • Flow Valve harness • VEB • Cable to CB/J14 • Control Board.
Heliox Mode is On	User Alarm	Control setting on ventilation setup menu.	When Heliox is used, the ventilator must adjust volume calculations.	
High O_2	User Alarm	O_2% > alarm high limit setting.	Is the limit set correctly? What is the O_2 flow? Did you just push Flush? Does the sensor see 21% O_2 in room air? Calibrate O_2 sensor. Replace O_2 sensor.	
High Paw	User Alarm	Paw is greater than Plimit. The ventilator cycles to expiration.	Are Plimit and other controls set correctly? Look for blockages. Check patient connection.	
High $\dot{V}_E$	User Alarm	The minute volume is greater than the set high limit. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient for spontaneous breathing. Adjust control settings.	
High V_{TE}	User Alarm	V_{TE} is greater than high alarm limit. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient for spontaneous breathing. Check ventilator and alarm settings.	
Insp Flow Sensor Fail	User Alarm	The system cannot read the calibration data stored in the sensor.	Operation continues with reduced accuracy. Replace the flow sensor.	
Insp Reverse Flow	User Alarm	Flow through the inspiratory sensor during expiration (for 6 breaths in a row).	Look at the check valves. Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken? Replace the inspiratory check valve. Check the flow sensor condition.	

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Inspiration Stopped ⚠	User Alarm	Drive gas safety switch activated (high pressure).	Adjust controls. Check systems for blockages.	If persists, check: • Bellows pop-off • Exhalation valve
Internal Ventilator Clock Too Fast	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Internal Ventilator Clock Too Slow	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Invalid Circuit Module	User Alarm	The system does not recognize the type of circuit module installed. Normally the system uses the ID tabs to identify circuits.	Make sure the module is correctly installed. Look for broken ID tabs or tape on the tabs.	If persists, check: • Circuit Identification Board • Harness to VMB • VMB • Cable to CB/J12
Low Battery Voltage	User Alarm	Voltage is <5.65V while using battery power.	Manually ventilate the patient to save power. Is the mains indicator light on? Make sure power is connected and circuit breakers are closed. Check the ventilator fuse.	
Low Drive Gas Press	User Alarm	The ventilator does not detect supply pressure.	Manually ventilate the patient. Make sure that the appropriate gas supplies (O_2 or Air) are connected and pressurized.	
Low O_2	User Alarm	O_2% less than alarm low limit setting.	Is the limit set correctly? Is the O_2 flow sufficient? Does the sensor see 21% O_2 in room air? Calibrate O_2 sensor. Replace O_2 sensor. As sensors wear out, the measured % O_2 decreases.	
Low Paw	User Alarm	Paw does not rise at least 4 cm above Pmin during the last 20 sec.	Are circuit connections OK? Look at the Paw gauge on the absorber. Look for circuit disconnection.	

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Low $\dot{V}_E$	User Alarm	Exhaled minute volume less than low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient condition. Check tubing connections. Check alarm settings.	
Low V_{TE}	User Alarm	Exhaled tidal volume less than low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient condition. Check tubing connections. Check alarm settings.	
Memory (EEPROM) Fail	User Alarm	The system cannot access some stored values.	Default settings are used. Ventilation is still possible but service is necessary.	Replace: • Control Board.
Memory (Flash) Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Memory (RAM) Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Memory (Redundant Storage) Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is still available.	Replace: • Control Board.
Memory (Video) Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Monitoring Only	User Alarm	A severe malfunction prevents mechanical ventilation. Other alarms may also occur.	Ventilate manually. Cycle system power (On- Standby-On). If the alarm clears, restart mechanical ventilation.	Replace: • Control Board.
No Circuit Module	User Alarm	The patient circuit module is not installed (Aestiva only).	Install a module. Optical sensors look for tabs on the back of the module. Is the module assembled? Are sensors dirty?	If persists, check: • Circuit Identification Board • Harness to VMB • VMB • Cable to CB/J12
No CO_2 Absorption	User Alarm	CO_2 bypass selected (Aestiva only).	User setting. Close the canister release to remove CO_2 from exhaled gas.	

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
No Exp Flow Sensor	User Alarm	Electrical signals show the flow sensor is not connected.	Connect the flow sensors. Make sure the flow sensor module is on all the way.	
No Insp Flow Sensor	User Alarm	Electrical signals show the flow sensor is not connected.	Connect the flow sensors. Make sure the flow sensor module is on all the way.	
No O_2 Pressure	User Alarm	The O_2 supply has failed.	Air flow will continue. Ventilate manually if necessary. Connect a pipeline supply or install an O_2 cylinder.	
O_2 Flush Failure	User Alarm	The pressure switch that detects flush flow has seen a very long flush (≥30 sec).	This alarm occurs if you hold down the Flush button for more than 30 seconds.	If persists, check: • O_2 flush switch • Cable to SICB • SICB • Cable to CB/J11
O_2 Sensor Out of Circ	User Alarm	O_2 sensor not installed in breathing circuit module. Sensor not measuring gas in breathing circuit.	Install a breathing circuit module and an O_2 sensor.	
O_2 Mon Disabled	User Alarm	An Oxygen cell has been connected to a non-active ventilator monitoring feature.	The Oxygen Monitoring feature is not active on this system.	Service Mode: • System Configurations
On Battery - Power OK?	User Alarm	The mains supply is not connected or has failed and the system is using battery power.	Ventilate manually to save power. At full charge, the battery permits approximately 30 minutes of mechanical ventilation. Make sure power is connected and circuit breakers are closed. Check the ventilator fuse.	
Patient Circuit Leak?	User Alarm	Exhaled volume <50% of inspired volume for at least 30 seconds (mechanical ventilation).	Check breathing circuit and flow sensor connections. Patient circuit leak audio can be turned off in the Alarm Settings menu.	

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Paw < -10 cm H_2O	User Alarm	Subatmospheric pressure (<-10 cm H_2O).	Check patient condition, spontaneous activity? Increase fresh gas flow. Look for high flow through gas scavenging. Calibrate the flow sensors. With active scavenging, check the negative relief valve on the receiver.	
PEEP Valve (DAC) Failure	Error Minimum Monitoring	Indicates a failure of the control circuit for the PEEP Valve.	Ventilate manually.	Replace: • Control Board.
PEEP Valve (Voltage) Failure	Error Minimum Monitoring	Indicates a problem with the PEEP Valve or the connections to the PEEP Valve.	Ventilate manually.	Check/Replace: • PEEP Valve • PEEP Valve harness • VEB • Cable to CB/J14 • Control Board.
PEEP Safety Valve (Drive) Failure	Error Minimum Monitoring	Indicates a higher than allowed current draw on the PEEP Safety Valve.	Ventilate manually.	Check/Replace: • PEEP Safety Valve • PEEP Safety Valve harness • VEB • Cable to CB/J14 • Control Board.
PEEP Safety Valve Failure	Error Minimum Monitoring	Indicates that the powerup test of the PEEP Safety Valve failed.	Ventilate manually.	Check/Replace: • PEEP Safety Valve • PEEP Safety Valve harness • VEB • Cable to CB/J14 • Control Board.
Pinsp Not Achieved	User Alarm	Indicates a problem with breathing circuit connections or that the ventilator is unable to deliver requested pressure to the patient.	Check breathing circuit connections. Check settings.	
Pressure Monitoring Channel Failure	Error Minimum Monitoring	Indicates a problem with patient airway overpressure monitor.	Ventilate manually.	Check/Replace: • VEB • Cable to CB/J14 • Control Board.

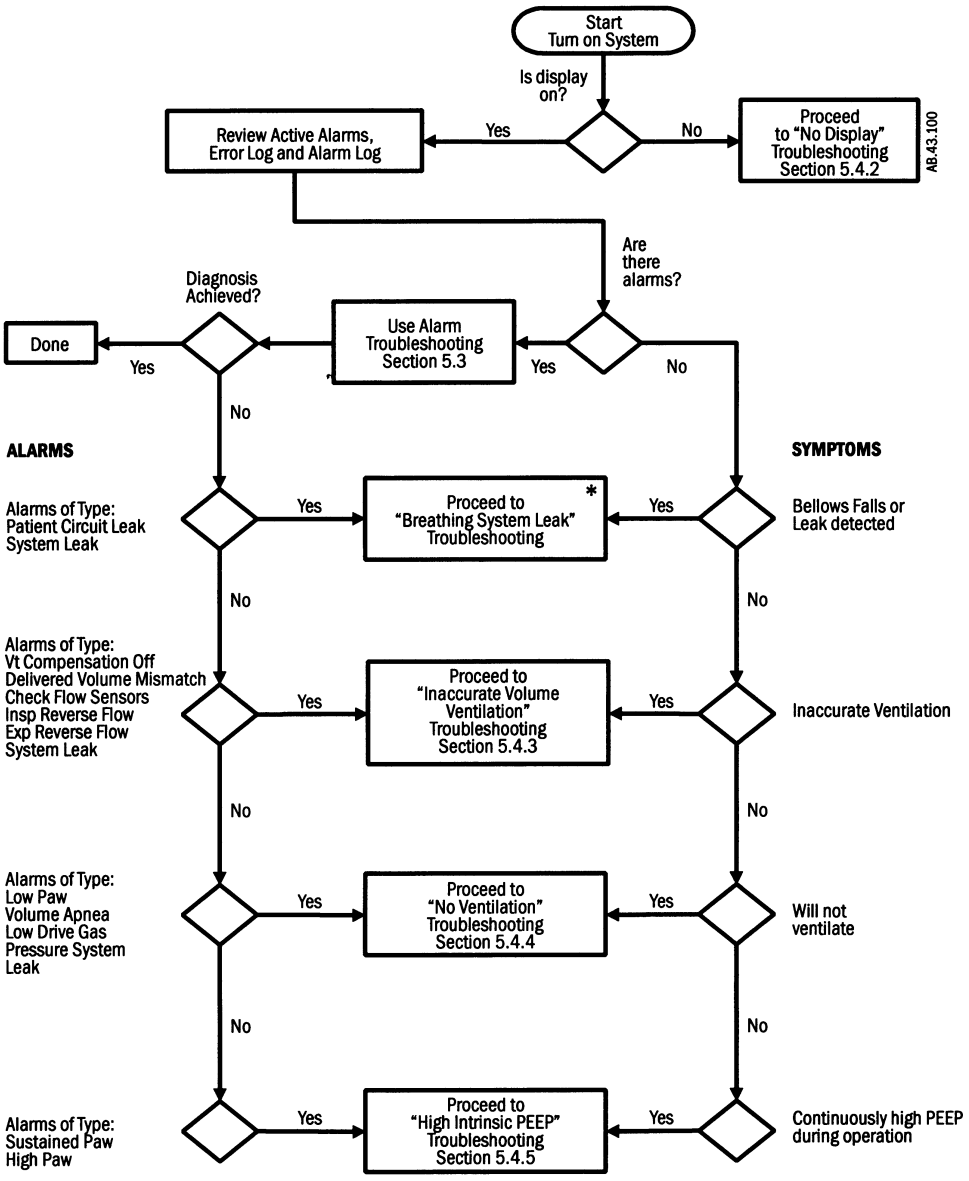
Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Pres/Vol Mon Inactive	User Alarm	ACGO is set to auxiliary gas outlet.	Connect the patient circuit to the auxiliary gas outlet or set the switch to the common gas outlet for normal operation.	
Replace O_2 Sensor	User Alarm	$O_2\% < 5\%$	Make sure patient receives O_2. Does the sensor see 21% O_2 in room air? Use different monitor. Calibrate O_2 sensor. Replace O_2 sensor.	If persists, check: • O_2 sensor cable • VMB • Cable to CB/J12 • Control board
Service Calibration ⚠	User Alarm	Internal calibrations are necessary for maximum accuracy.	The system is operational.	Service Mode: • Calibrations
Select Gas Outlet	User Alarm	Fresh gas may not flow to the patient. ACGO is On, but flow sensors have seen 3 breaths in patient circuit during the last 30 seconds.	Select the common gas outlet or connect the patient circuit to the ACGO. Note: The bag arm will not ventilate a patient at the auxiliary outlet.	
Software Error	Error Minimum Shutdown	Indicates that a software error has occurred.	Ventilate manually. Monitoring is not reliable.	Replace: • Software • Control Board.
Software Watchdog Failure	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Sustained Airway Pressure	Error Minimum Shutdown	Paw > 100 cm H_2O for 10 sec.	Check tubing for kinks, blockages, disconnects. Calibrate the flow sensors.	If persists, check: • Bellows pop-off • Exhalation valve
Sustained Paw	User Alarm	Paw is greater than sustained pressure limit for 15 seconds.	Check tubing for kinks, blockages, disconnects. Calibrate the flow sensors.	
System Configuration (EEPROM) Memory Failure	Error Minimum Shutdown	System configuration information is bad in the EEPROM Memory.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
System Leak?	User Alarm	Leak detected between ventilator and patient circuit.	If you are using Heliox, select Heliox on the ventilator setup menu. Look for leaks in the absorber system. Problem with flow sensors? Calibrate the flow sensors. Drain water buildup from the breathing system and inspect for leaks (repair). Inspect or replace flow sensors.	The primary cause for this message is that the bellows has emptied. Refill the bellows. This message combines the "Unable to Drive Bellows" and "System Leak?" messages in the Aestiva 7900 Ventilator. Perform the Breathing System Leak Tests.
Vext_ref Out-of-Range	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
VBUS Fail Out-of-Range	Error Minimum Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • Control Board.
Ventilate Manually	User Alarm	A severe malfunction prevents mechanical ventilation and monitoring. Other alarms may also occur.	Ventilate manually. Use a stand-alone monitor. Cycle system power (On-Standby-On). If the alarm clears, restart mechanical ventilation.	Replace: • Control Board.
Verify Low $\dot{V}_E$ Limit	User Alarm	The audible circuit leak alarm is off (Alarm Settings menu) but the low $\dot{V}_E$ alarm is not consistent with the ventilator settings.	Set the low $\dot{V}_E$ alarm.	
Volume Apnea	User Alarm	No mechanical breaths or spontaneous breaths > 5 mL in last 30 seconds.	Check patient. Bag as needed. Check for disconnects. If the patient is on a heart lung machine, select Cardiac Bypass on the alarm menu.	
Vol Apnea > 2 min	User Alarm	No mechanical breaths or spontaneous breaths >5 mL in last 120 seconds.	Check patient. Bag as needed. Check for disconnects. If the patient is on a heart lung machine, select Cardiac Bypass on the alarm menu.	

Message	Alarm/Error	Cause	User Action/Concerns	Service Repair
Volume Mon Disabled	User Alarm	A flow sensor has been connected to a non-active ventilator monitoring feature.	The Volume Monitoring feature is not active on this system.	Service Mode: • System Configurations
V_T Comp Avail	User Alarm	A condition which prevented V_T Compensation ventilation mode has cleared.	None. Indicates a return to normal operation. Select Volume Mode or Pressure Mode (if available).	
V_T Comp Off	User Alarm	The system supplies the set breath but cannot adjust ventilation for compliance and resistance losses, etc.	Adjust V_T manually and continue without compensation, or change to the pressure mode. In pressure mode set Pinspir. Replace the flow sensor module and select the mode again. If the problem stops, inspect the two flow sensors.	
V_T Comp Disabled	User Alarm	A flow sensor has been connected to a non-active ventilator monitoring feature.	The Volume Compensated Delivery feature is not active on this system.	Service Mode: • System Configurations
V_T Not Achieved	User Alarm	Tidal volume measured by inspiratory flow sensor is less than set value 6 breaths in a row after the first minute of mechanical ventilation.	Adjust controls to supply adequate tidal volumes. Check I:E; Plimit; and volume settings. Possible leak.	
V_{TE} > Insp V_T	User Alarm	Expired volume is greater than inspired volume for 6 breaths with a circle module.	Check patient condition. Are the flow sensors correctly installed? Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken? Improper check valve operation? Inspect one-way valves (breathing circuit module.) Replace flow sensor module with the spare. Check the condition of the flow sensor and its tubing.	
V_T Delivery Too High	User Alarm	V_T > 20% of set value for six consecutive breaths.	Reduce fresh gas flow.	

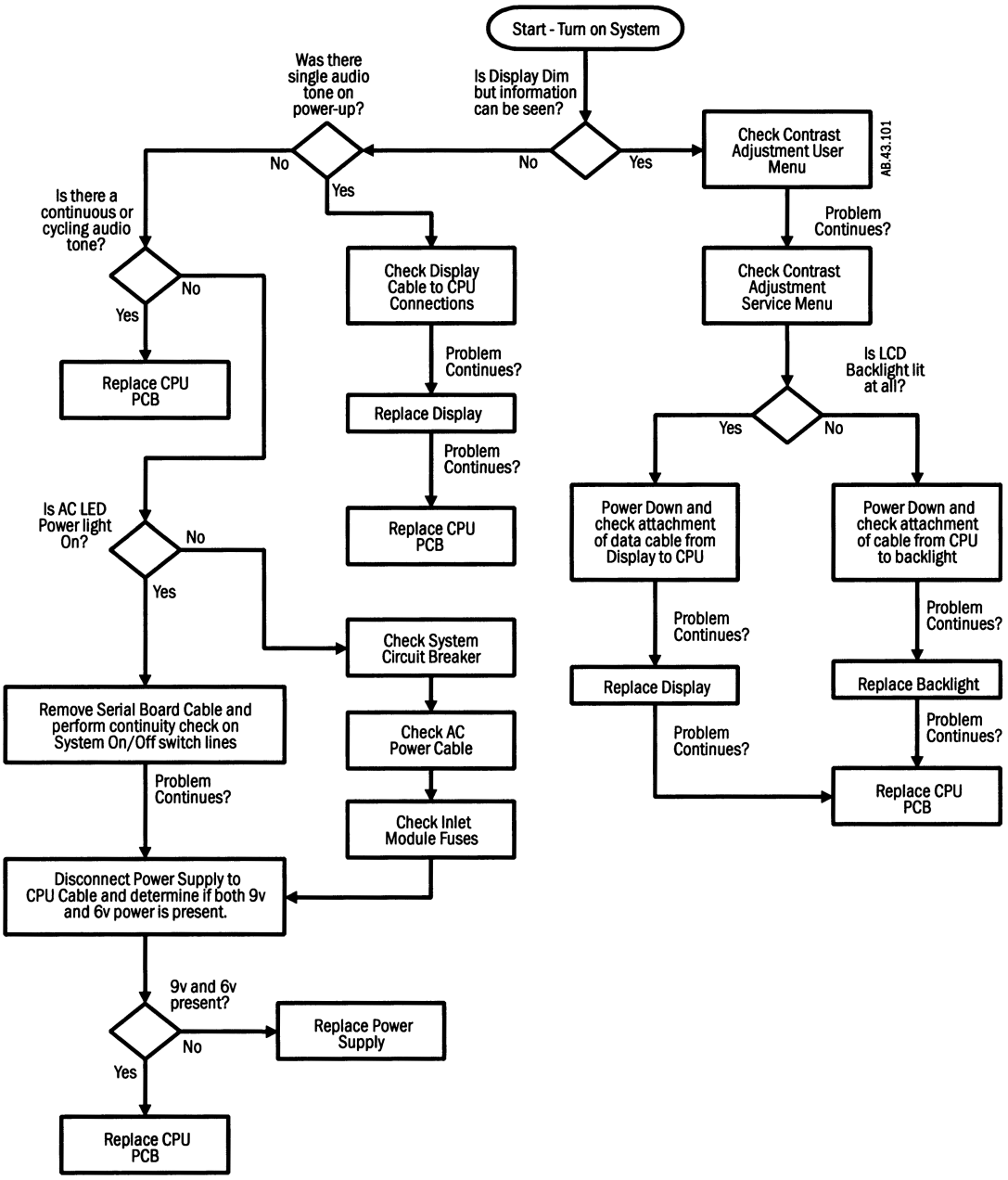
7.5 Troubleshooting Flowcharts

7.5.1 Ventilator assessment process

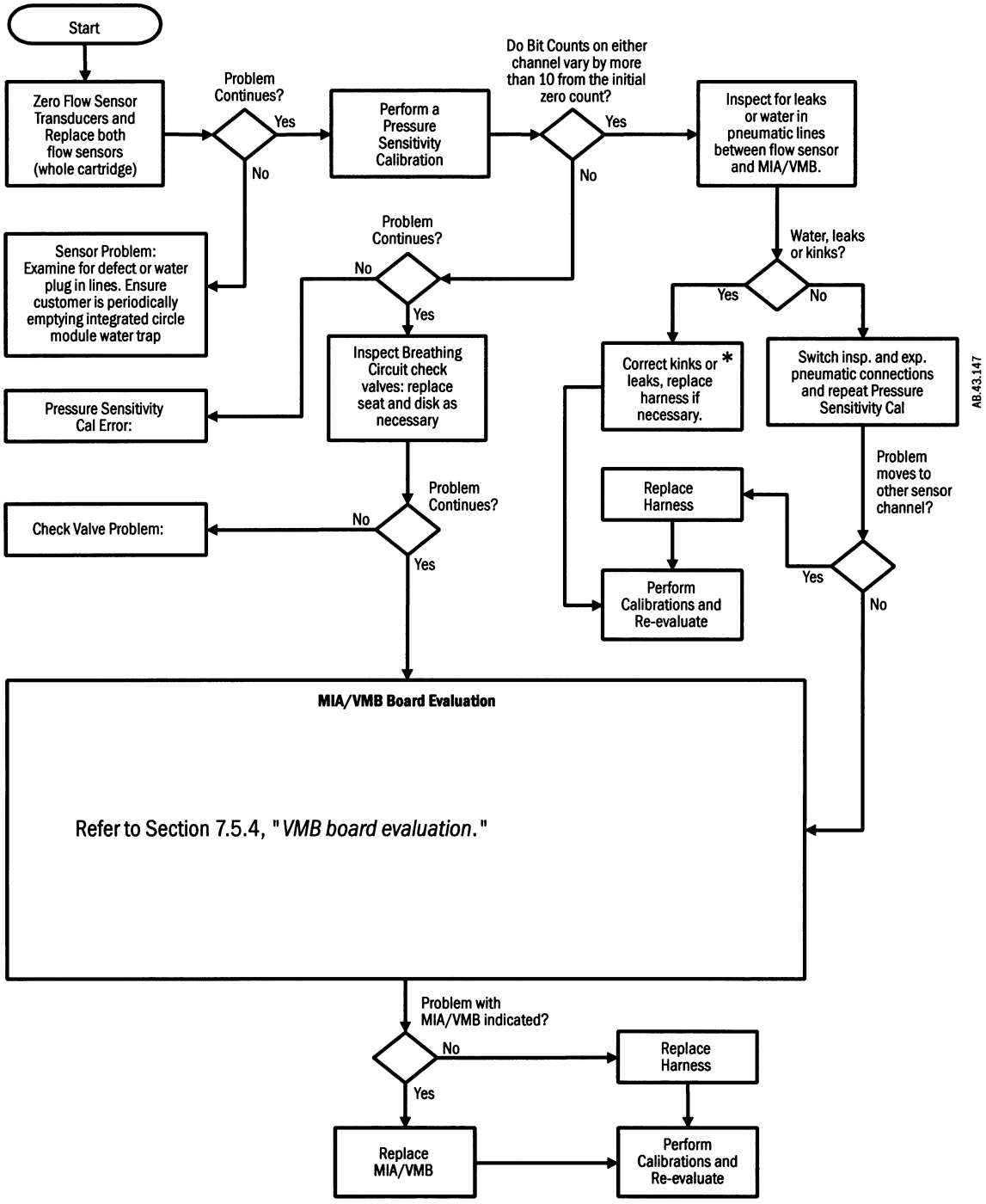


* Refer to Section 7.2, *"Breathing System Leak Tests,"* in the respective anesthesia machine Technical Reference Manual.

7.5.2 No display troubleshooting

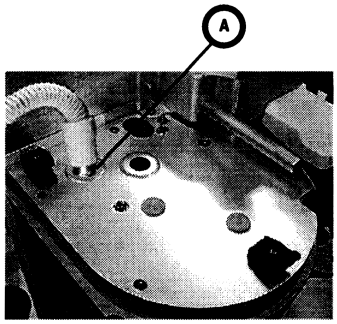


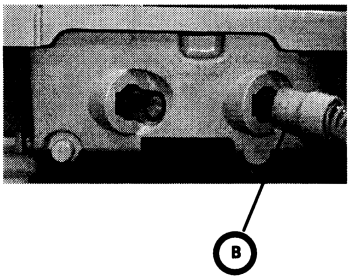
7.5.3 Inaccurate volume ventilation troubleshooting



* Water in harness is indicative of a leak in the tubing, connectors, or MIA/VMB pressure transducer. Be sure to leak check if it is determined that water is present within the harness.

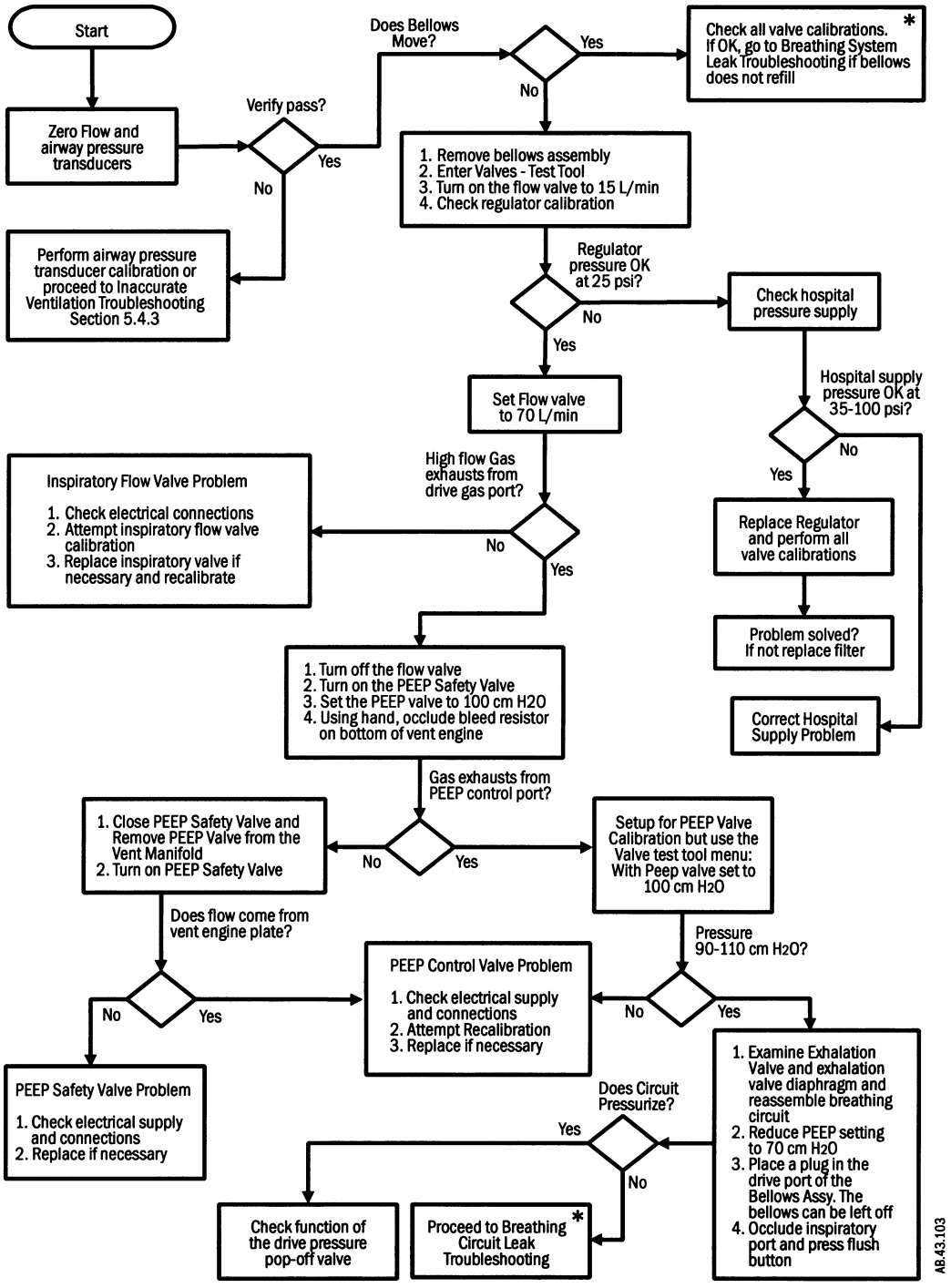
7.5.4 VMB board evaluation





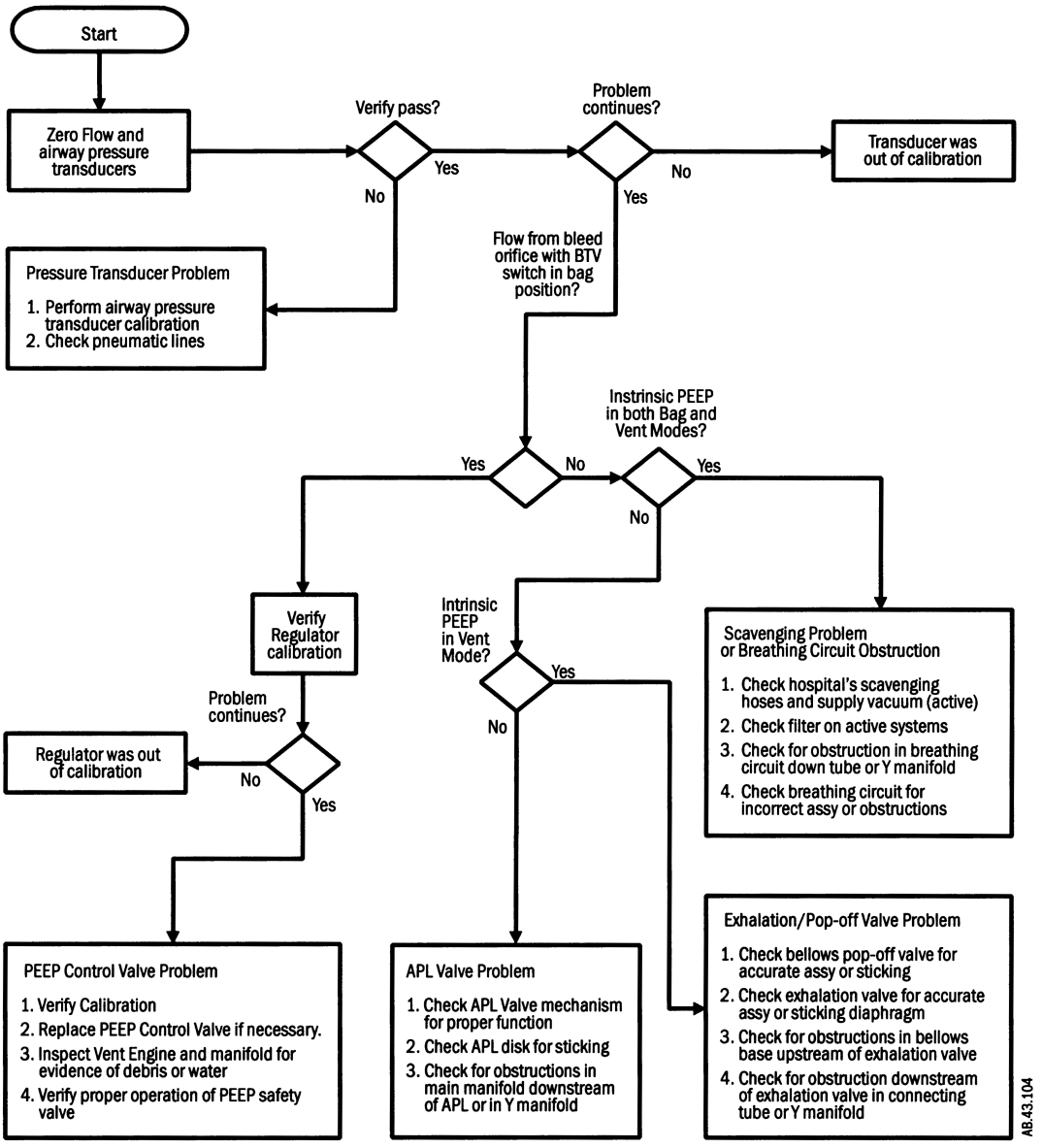
1. Remove the tabletop to access the VMB pneumatic circuit connections.
2. Remove the ABS and the exhalation valve.
3. Enter the Valves-Test Tool service page and record the bit counts on the inspiratory and expiratory flow transducers.
4. Connect the calibration orifice test tool (**A**) to the drive gas port (not the pilot pressure port used for PEEP calibration).
5. Separate the Bellows Module from the Circuit Module.
6. Remove the Flow Sensor Module from the ABS and install it on the machine.
7. Install the Circuit/Flow Sensor Module.
8. Connect a 22-mm hose from the calibration orifice test tool to the inspiratory flow port (**B**).
9. Set the inspiratory flow valve to 60 L/min. Gas will exhaust out the rear of the inspiratory flow sensor where it is normally connected to the circuit module (reverse flow through the inspiratory flow sensor).
10. Record the change in bit counts observed on the inspiratory flow transducer channel as compared to step 2 (negative polarity). There may be some variation in the last digit of the counts, try to pick the average value.
11. Stop the inspiratory flow.
12. Swap the inspiratory channel pneumatic connections (white to black, black to white) – Refer to Figure 11-7.
13. Repeat steps 9 through 11.
14. Move the two inspiratory connections to the expiratory channel of the VMB (white from harness to blue of VMB pressure transducer, black from harness to yellow of VMB pressure transducer).
15. Repeat steps 9 through 11 using counts from the expiratory flow transducer channel.
16. Swap the two inspiratory connections to the expiratory channel of the VMB (white from harness to yellow of VMB pressure transducer, black from harness to blue of VMB pressure transducer).
17. Repeat steps 9 through 11 using counts from the expiratory flow transducer channel.
18. Variation of greater than 40 bits in any of the four measured count changes indicates a problem with the VMB function.
19. Return to Section 7.5.3.

7.5.5 No ventilation troubleshooting



* Refer to Section 7.2, *"Breathing System Leak Tests,"* in the respective anesthesia machine Technical Reference Manual.

7.5.6 High Intrinsic PEEP troubleshooting



8 Software Installation

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8.1.1 Key/BID label (Key Code) 8-3

8.2 After replacing the Control Board or the Control Module 8-4

8.2.1 Calibration and Checkout 8-5

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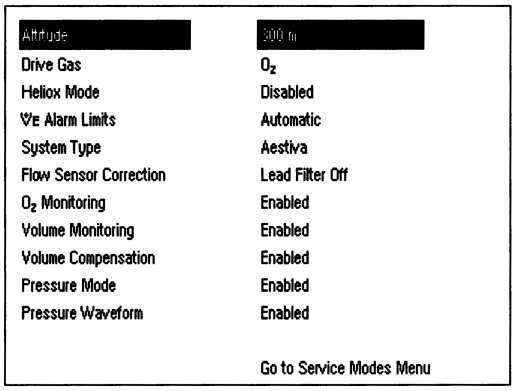
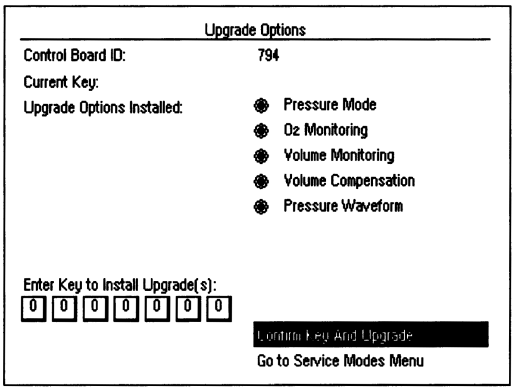
8.1 Before installing new software or replacing the Control Board

When new system software is installed, the System Configuration settings (Section 4.8) are reset to the default values and the Upgrade Options are reset to "not installed" (Section 4.11).

Refer to Section 4.8



Refer to Section 4.11



To help ensure that, after repair or software replacement, the Aespire 7100 system will include all features that are currently installed and enabled, record the current System Configuration menu settings and the Upgrade Options installed.

The first six items are present in all machines:

- ***Altitude***: (specific to location)
- ***Drive Gas***: O_2 or Air
- ***Heliox Mode*** (set to Disabled for Aespire 7100)
- ***Ve Alarm Limits***: Automatic or User Adjustable
- ***System Type***: (set to Aestiva by default)
- ***Flow Sensor Correction***: Lead Filter Off or Lead Filter On

The remaining settings are only present in machines that include the optional features:

- ***O2 Monitoring***: Enabled or Disabled
- ***Volume Monitoring***: Enabled or Disabled
- ***Volume Compensation***: Enabled or Disabled
- ***Pressure Mode***: Enabled or Disabled
- ***Pressure Waveform***: Enabled or Disabled

8.1.1 Key/BID label (Key Code)

The replacement Control Board (Control Module) includes a Key/BID label that is appropriate for machines that include all of the optional features. If the machine includes only some of the optional features, access the Key Code Generator web site to obtain the appropriate optional features Key Code.

1. Gather the following information (* denotes Required Information):

Requestor Information	
* Email Address	
* Full Name	
* Organization	
End User Information	
Hospital Name	
Address 1	
Address 2	
City	
Postal Code	
Country	
Telephone	
Information from the EXISTING Control Board being REMOVED	
* Control Board ID number	
* Control Board Key Code	
Information from the REPLACEMENT Control Board being INSTALLED	
* Control Board ID Number	

2. Access the Key Code Generator on the following web site.
   - http://www.docodes.com
3. Enter the required information and Submit the Request.

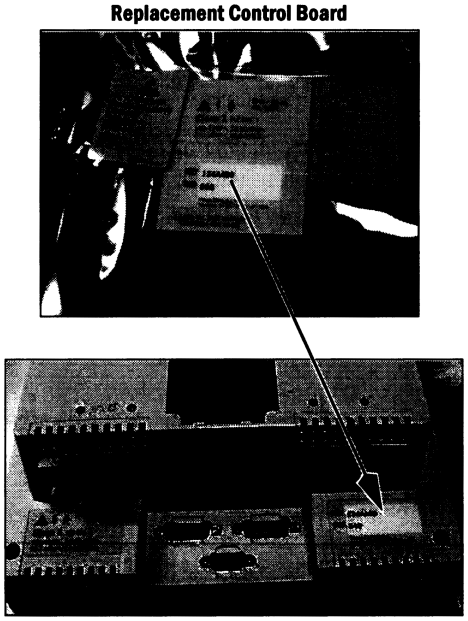
An e-mail with the replacement Control Board Key Code will be immediately sent to the e-mail address provided (*due to delays in some firewalls and internet traffic, responses can take up to 24 hours to receive*).

Note: For traceability, the Global Service and Support Helpdesk is copied on the e-mail.

8.2 After replacing the Control Board or the Control Module

1. Load the appropriate software revision (Section 8.3) using a software memory stick that matches the software revision of the replaced control board (control module).
2. Activate the appropriate options on the ***Upgrade Options*** menu (Section 4.11).
   A. If the original configuration included all of the optional features, enter the Key Code supplied with the replacement Control Board (Control Module) following Steps a. through d., below.
   B. If the original configuration included only some optional features, enter the Replacement Control Board Key Code obtained from the Key Code Generator web site, as follows.
      a. Enter the ***Service Mode***.
      b. Select ***Upgrade Options***.
      c. Prior to installing the new Key Code, reset the options key by entering the following key code: G000000.
      d. Then enter the appropriate Key Code to restore the original Upgrade Options.
3. On the ***System Configuration*** menu, reset the configuration to match the settings recorded in Section 8.1
4. If required, record the new (web site generated) Key Code on the label provided in the replacement Control Board kit (or on the Control Module).
5. Affix the label to the back of the display module as shown.

Replacement Control Board

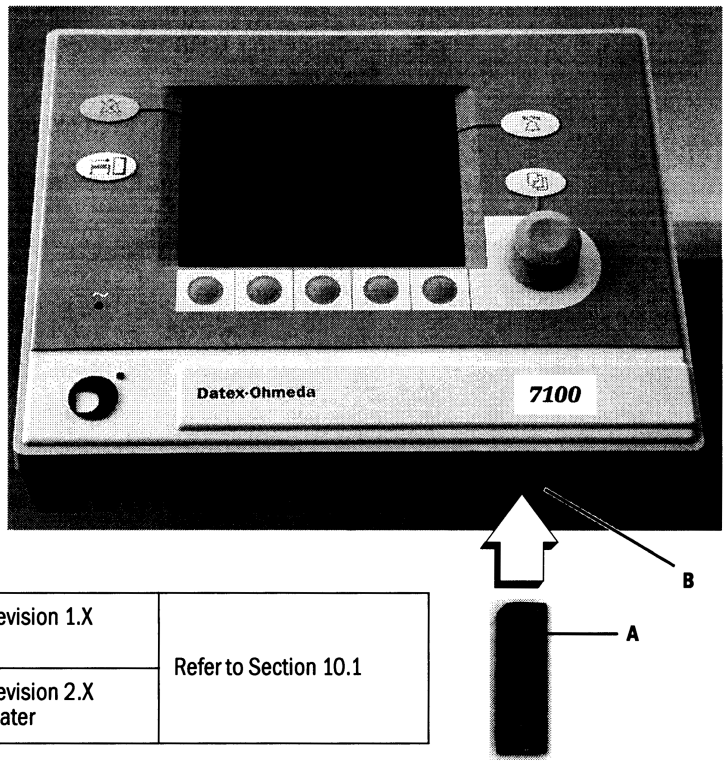


8.2.1 Calibration and Checkout

1. Enter the ***Service Mode***.
2. Select ***Calibrations***.
3. On the ***Calibrations*** menu, select ***Service Calibrations Required ⚠***.
4. On the ***Service Calibrations Required ⚠*** menu, select ***Set "Service Calibrations Required ⚠"***.
5. Select ***Yes*** to the ***Do you want to Set Service Calibration?*** prompt.

   The system will determine which calibrations are required for the feature options installed.
6. Perform all required calibrations.
7. Perform a full system checkout (Section 3).

8.3 Software Installation



Software Memory Stick, (for non-color display)	SW Revision 1.X	Refer to Section 10.1
Software Memory Stick, (for color and non-color display	SW Revision 2.X or greater	

1. Set the system switch to Standby.
2. Insert the Software Memory Stick (**A**) with contacts facing forward into the upgrade slot (**B**) of the Control Module.
3. Set the system switch to On.
4. Follow the instructions on the screen to complete the installation.
5. Set the system switch to Standby.
6. Remove the Software Memory Stick.
7. On the ***Upgrade Options*** menu (Section 4.11) of the ***Service Mode***, enter the options Key Code found on the back of the display to restore the original Upgrade Options.
8. On the ***System Configuration*** menu (Section 4.8) of the ***Service Mode***, reset the configuration to match the settings recorded in Section 8.1
9. Perform the preoperative checkout procedure.

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⚠ WARNING To prevent fires:

- Use lubricants approved for anesthesia or O_2 equipment, such as Krytox.
- Do not use lubricants that contain oil or grease; they burn or explode in high O_2 concentrations.
- All covers used on the system must be made from antistatic (conductive) materials. Static electricity can cause fires.

⚠ Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

⚠ A movable part or a removable component may present a pinch or a crush hazard. Use care when moving or replacing system parts and components.

⚠ When servicing the ventilator, extreme care must be taken to avoid introducing foreign debris, particularly metal chips generated by screw threads, into the pneumatic flow passages of the ventilator. Failure to do so can result in damage to the flow valve and possible injury to the patient.

⚠ Some internal parts have sharp edges and can cause cuts or abrasions. Use care when servicing internal components.

⚠ After repairs are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

9.1 How to bleed gas pressure from the machine

Before disconnecting pneumatic fittings, bleed all gas pressure from the machine.

1. Set the system switch to On.
2. Close all cylinder valves and disconnect all pipeline supplies from the source.
   Note: If the machine includes N_2O, do not disconnect the O_2 pipeline.
   If pipeline O_2 is not available, open the O_2 cylinder valve.
3. Turn the flow controls for all gases (except O_2) at least one turn counterclockwise.
4. Ensure that all cylinder and pipeline gauges read zero before proceeding.
   - For machines with N_2O, disconnect the O_2 pipeline supply from the source (or close the O_2 cylinder valve).
   - Press the O_2 flush button to bleed O_2 from the system.
5. Set the system switch to Standby.

9.2 How to remove the rear panels

You must remove the rear upper panel to repair or replace many of the machine's components. To access the 3rd cylinder supply (if equipped) you must remove the lower access panels.

9.2.1 To remove the rear upper panel

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Disconnect all electrical cables.
4. To remove the rear panel, fully loosen the three captive screws that hold the panel in place. Remove the panel.
   - If the machine includes integrated suction, disconnect the two tube fittings from the overflow safety trap manifold.
   - If the machine includes electrical outlets, lower the panel and place it so that it does not stress the power cable.

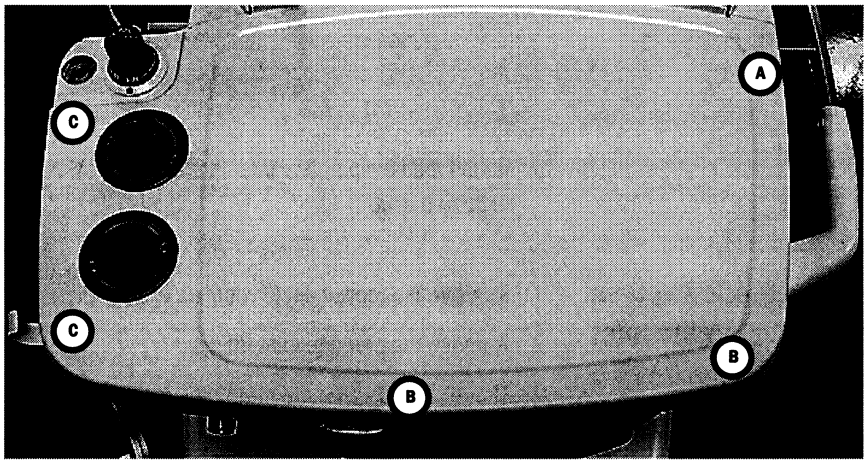
9.2.2 To remove the lower access panels

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. If present, remove the inboard cylinders.
4. Remove (two screws) the small upper access panel to access the 3rd cylinder regulator (N_2O) test port.
5. Remove (six screws) the large lower access panel to access the 3rd cylinder regulator.

9.3 How to remove the tabletop

The tabletop is held in place with five captive screws along the periphery of the pan assembly (accessed from below the rim of the tabletop).

- One screw (**A**) is in a deep recess at the right-rear corner of the tabletop.
- Two screws (**B**) are at the front of the tabletop: one screw is at the right corner of the tabletop, one is near the O_2 Flush button.
- To access the remaining two screws (**C**), you must remove the ABS: one screw is at the left corner of the tabletop, one is near the APL Valve.

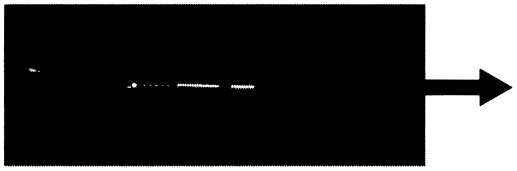


9.4 Servicing the pipeline inlet manifold components

The pipeline inlet filter and the inlet check valve can be replaced without removing the pipeline manifold from the machine.

9.4.1 Replace pipeline inlet filter

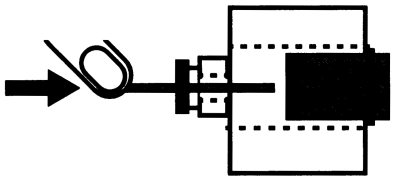
1. Remove the pipeline inlet fitting.
2. Pull the pipeline inlet filter out of the fitting. The o-ring should come out with the filter.



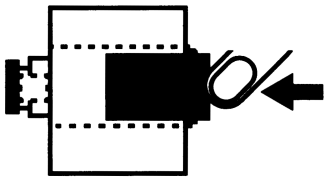
3. Install the new pipeline inlet filter in the pipeline inlet fitting. The new filter comes with an o-ring.

9.4.2 Replace pipeline inlet check valve

1. Remove the rear panel (Section 9.2).
2. Remove the pipeline inlet fitting.
3. The Air and O_2 pipeline manifolds include a drive gas connection at the back of the manifold. Remove the drive gas tube or plug to access the check valve.
4. From the back of the pipeline manifold, use a thin tool to push out the check valve. (For an N_2O manifold, you will have to carefully apply pressure at the outlet of the manifold – with a syringe for example – to gently force the check valve out of the manifold).



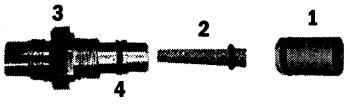
5. Push the new check valve into the opening, using the same thin tool. The new check valve includes an o-ring – orient it toward the pipeline inlet. **Note:** Make sure to push the new check valve all the way back into the opening until it bottoms out on the shoulder.

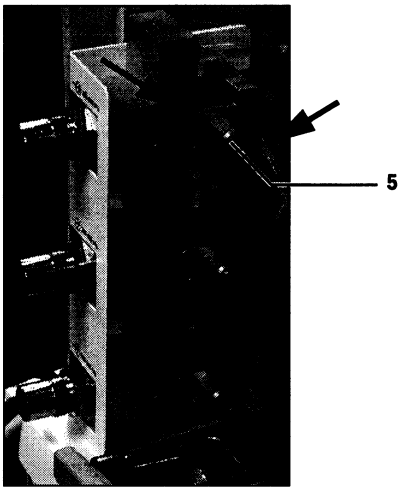


6. Install the pipeline inlet fitting.

9.4.3 Replace the inlet manifold

1. Remove the rear panel (Section 9.2).
2. Disconnect the tubing from the manifold outlet(s).
3. Remove the two screw that hold the manifold to the side extrution.





4. Transfer the following item to the replacement manifold or install new as required.
   - pipeline check valve (1)
   - inlet filter (2)
   - inlet fitting (3) and o-ring (4)
   - relief valve (5)
5. To reassemble, perform the previous steps in reverse order.
6. Perform the checkout procedure (Section 3).

9.5 Service the cylinder supply modules

⚠ WARNING Be careful not to expose internal components to grease or oil (except Krytox or equivalent).

9.5.1 Tightening procedure for high-pressure tube fittings

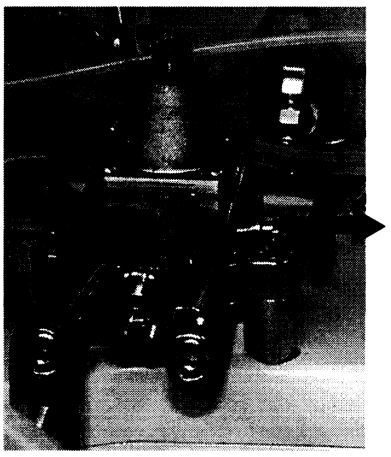
The cylinder pressure gauge is connected to the cylinder supply through a copper tube with fittings at both ends. Use the following tightening procedure whenever you are replacing a cylinder supply or a cylinder pressure gauge.

1. Insert the tubing into the fitting until the ferrule seats in the fitting.
2. Tighten the nut by hand.
3. Continue tightening the nut with a wrench until it reaches the original position (about 1/4 turn). You will feel an increase in resistance at the original position.
4. After reaching the original position, tighten the nut just slightly.

Note If you are installing a new tube that has not been tightened before, tighten the nut with a wrench an additional 3/4 of a turn after the nut is finger tight.

9.5.2 Replace primary regulator module (complete replacement)

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the rear panel (Section 9.2).
4. Disconnect the high-pressure cylinder gauge fitting.
5. Disconnect the output tube fitting.
6. Remove the three mounting screws and lockwashers.
7. To reassemble, perform the previous steps in reverse order.
   - Tighten the high-pressure fitting as detailed in Section 9.5.1
   - Pull on the cylinder output fitting to ensure it is locked in place.
8. Check the output of the regulator BEFORE you install the rear panel. Adjust if necessary (Section 5.1).
9. Perform the checkout procedure (Section 3).

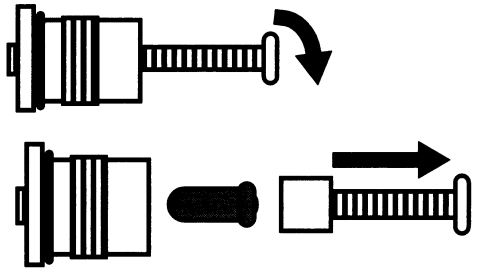


9.5.3 Replace cylinder inlet filter

1. Open the cylinder yokes.
2. Remove the inlet adapter from the cylinder yoke, using a 4 mm hex wrench.

   Note: A brass retaining ring keeps the filter inside the inlet adapter.
3. Thread a 6-mm screw (two turns only) into the brass retaining ring and pull it out.

⚠ CAUTION Be careful not to crush the filter. Do not thread in the screw more than two full turns.



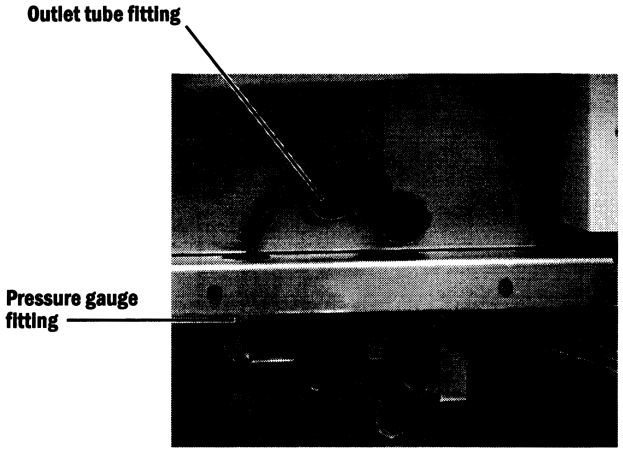
4. Remove the filter.
5. Install the new filter and brass retaining ring.
6. Install the inlet adapter in the cylinder yoke.
7. Perform the checkout procedure (Section 3).

9.5.4 Replace cylinder check valve

The cylinder check valve is not a replaceable item. If the check valve is defective, you must replace the complete cylinder supply module.

9.5.5 Replace 3rd-gas cylinder supply module

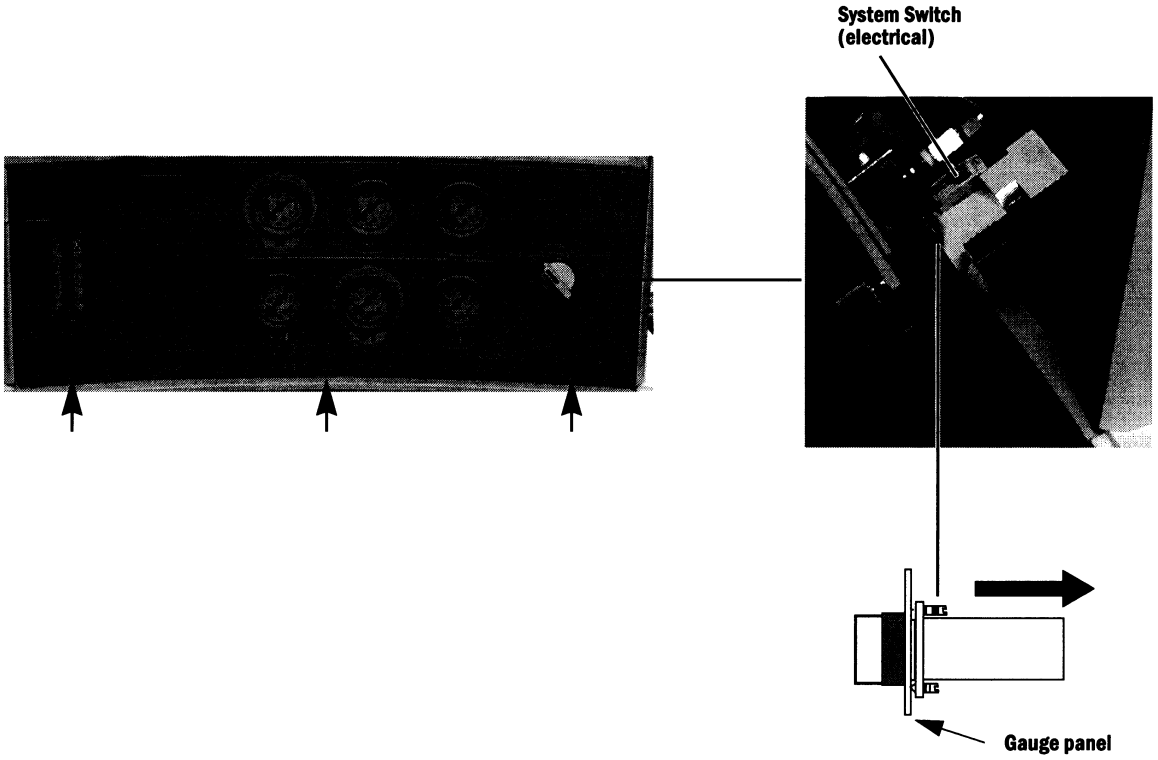
1. Remove the lower rear cover (Section 9.2.2).
2. Disconnect the high-pressure cylinder gauge fitting.
3. Disconnect the output tube fitting.
4. Remove the three mounting screws and lockwashers.



5. To reassemble, perform the previous steps in reverse order.
   - Tighten the high-pressure fitting as detailed in Section 9.5.1
   - Pull on the cylinder output fitting to ensure it is locked in place.
6. Check the output of the regulator BEFORE you install the rear cover. Adjust if necessary (Section 5.1).
7. Perform the checkout procedure (Section 3).

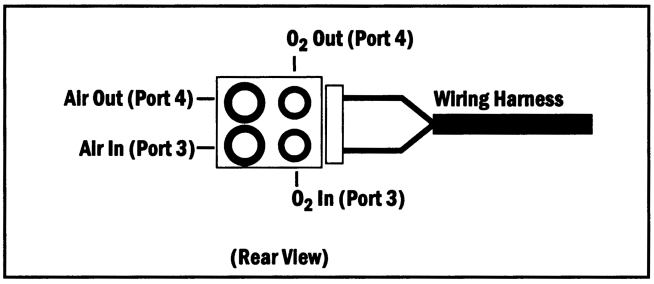
9.6 Replace system switch assembly

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the tabletop (Section 9.3).
4. Remove the gauge panel mounting screws and move the panel forward to access the system switch.



5. Disconnect the wires from the electrical switch.
6. Back out the system switch mounting screws just enough to allow the knob collar to be released.
7. While holding the switch assembly, push in the knob and turn it counterclockwise.
8. Pull the knob and collar out from the front and remove the switch assembly.

9. Install the replacement switch assembly:
   a. Loosen the two outside screws on the electrical module.
   b. Insert the wires in the electrical module and tighten the screws.
   c. Pull the wires on the electrical module to ensure that there is a good connection.
   d. Turn back the system switch mounting screws until their tips recede.
   e. Orient the switch assembly with the Air fittings toward the right and the O_2 fittings toward the left.
   f. Install the switch assembly through the gauge panel.
   g. Push the knob collar in with the indicator up and turn it clockwise until it locks.
   h. Tighten the mounting screws. Make sure that the top edge of the switch assembly is parallel to the top edge of the gauge panel.
   i. Transfer the tubing from the old system switch to the new system switch on the pneumatic module (pull on the tubing to ensure that it is locked into the module).

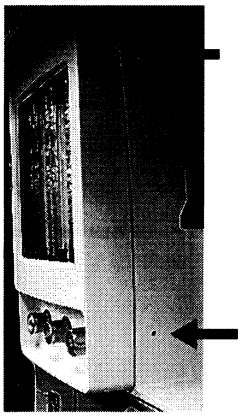


10. Test the replacement switch assembly:
    a. Connect Air and O_2 supplies.
    b. Connect the power cable to an electrical outlet.
    c. Set the system switch to On.
    d. Increase the O_2 and Air flow. Make sure that gas flows.
    e. Make sure that you do not feel or hear any leaks.
    f. Make sure that the display comes On.
    g. Set the system switch to Standby.
    h. Make sure all gas flow stops and the display turns Off.
11. Reinstall the gauge panel and the tabletop.
12. Perform the checkout procedure (Section 3).

9.7 Service the flowmeter module

9.7.1 Remove front flowmeter panel shield

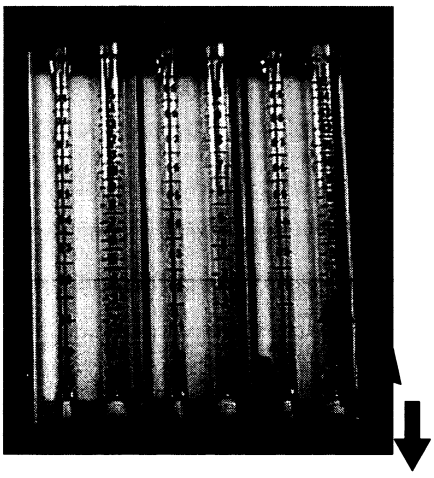
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. The flowmeter panel is held in place with two latching tabs at the right side. To remove the panel, release each latch by pushing it toward the center of the panel with a thin rod (3-mm hex wrench) through the access hole in the shroud.



4. Remove the panel.
5. To reinstall the panel, engage the retaining tabs on the left side and press the right side against the shroud to latch it in place.

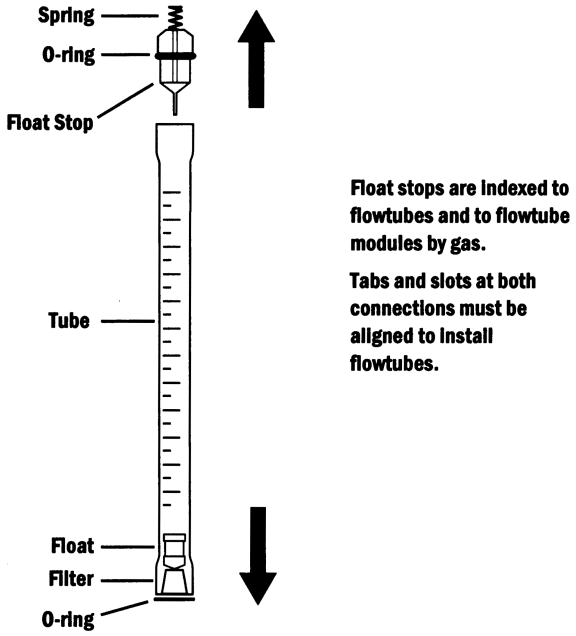
9.7.2 Remove flowtubes for cleaning or replacement

1. Remove the front flowmeter panel shield (Section 9.7.1).
2. To remove a flowtube assembly, push up on the tube just enough to clear the bottom seal, pull out from the bottom until the tube clears the flowtube module, then pull down slowly to release it from the module.



⚠ WARNING Floats are calibrated to a specific tube. Keep each float with its tube. Replace tube and floats together. Interchanging floats can cause incorrect readings. Disassemble the flowtube assemblies only when service is required. Excessive cleaning can remove the antistatic coating from inside the tube. Damage to the float requires replacement of the entire flowtube.

3. Disassemble the flowtube assembly.

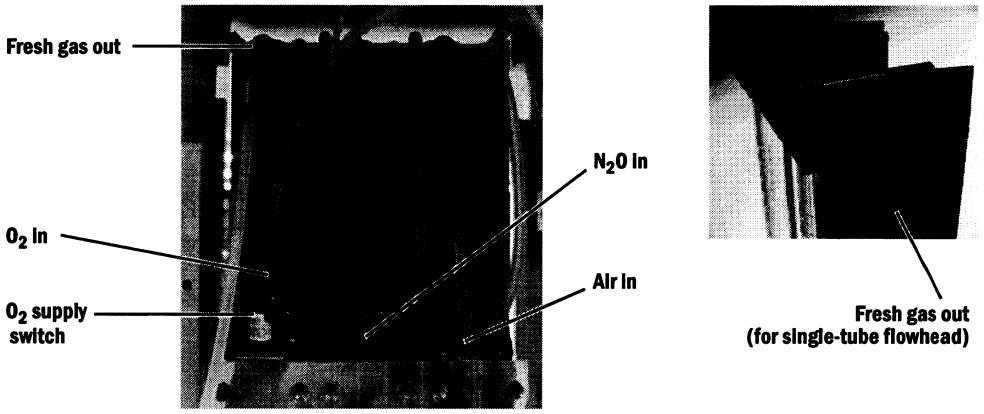


4. Completely clean, rinse, and dry the flowtube. Use hospital grade alcohol and a flowtube brush.
5. Replace stops, filter and o-rings, as necessary. Lightly coat all o-rings with Krytox. Be careful to not get any Krytox on the bottom of small flowtube float stops.
6. Reassemble the flowtube assembly.
7. Insert the flowtube, spring side first, into the top of the module with the scale oriented forward.
8. Push up and slide the bottom of the flowtube into place on the bottom o-ring. It may be necessary to rotate the tube to engage the index tabs.

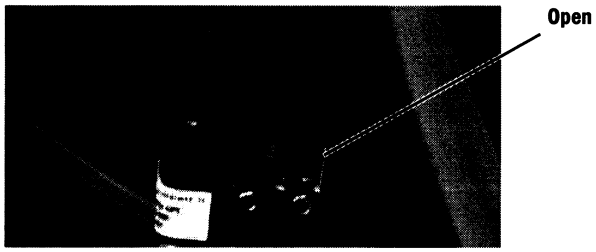
   Note: Be sure o-rings are inserted completely into the collar.
9. Push down on the tube to seat the bottom o-ring.
10. Reinstall the front flowmeter panel shield.
11. Perform the checkout procedure (Section 3).

9.7.3 Remove complete flowmeter head

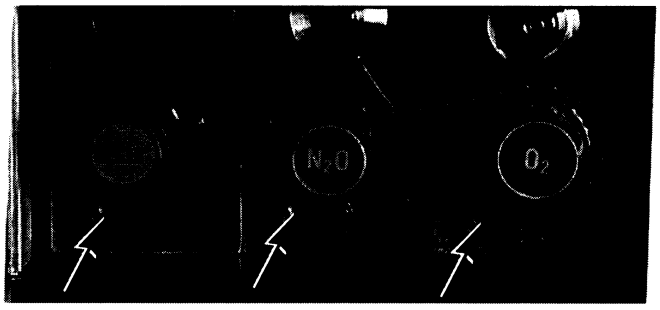
1. Remove the rear panel (Section 9.2).
2. Disconnect the tubing at the rear of each gas module. The following example is a back view of the flowmeter head.



3. Disconnect the O_2 supply switch harness. Note position of switch connections so that you can reassemble correctly later.



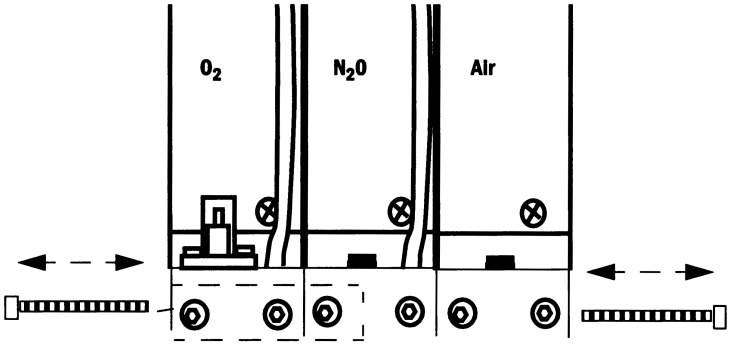
4. Remove the front flowmeter panel shield (Section 9.7.1).
5. Remove the mounting screw from each regulator manifold.



6. Pull the flowhead forward.
7. To reinstall, perform the previous steps in reverse order (pull on the tubing to ensure it is locked into the fittings).
8. Check for proper alignment of the front flowmeter panel. If any of the needle valve knobs rub against the flowmeter panel, reposition the flowhead to allow for proper clearance.
9. Perform the checkout procedure (Section 3).

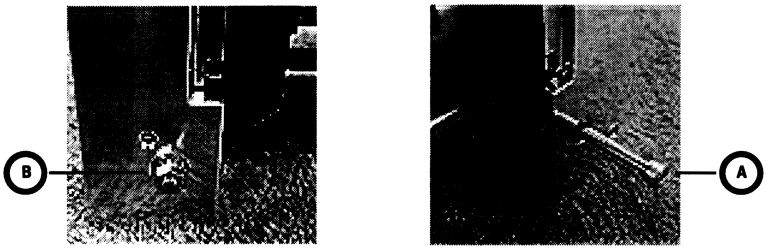
9.7.4 Replace flowmeter modules

1. Remove the complete flowmeter head (Section 9.7.3).
2. Refer to the following illustrations. Note that these illustrations show ANSI flowmeter module positions. The order is reversed in ISO machines.



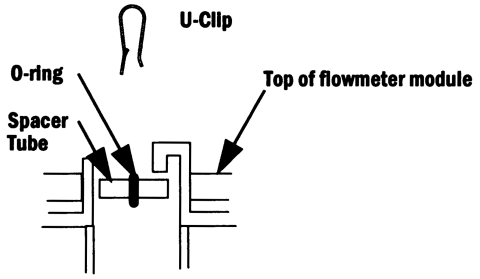
O_2/Air modules

O_2/Air flowmeter modules are connected at the bottom with a long screw (**A**) and nut (**B**) that is recessed. To remove, retain nut while loosening screw.



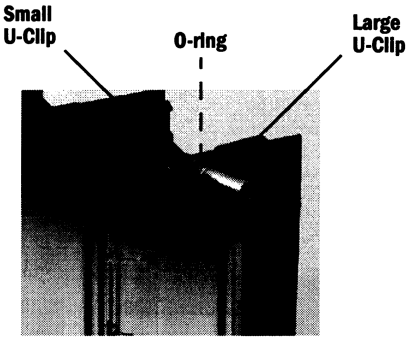
Note The flowmeter modules are held together at the top with a u-clip. To separate the modules, pivot the modules (front to back) 45 degree. The u-clip will disengage and allow the modules to separate.

The flowmeter modules are interconnected at the top by a spacer tube. The o-ring on the spacer tube makes a leak-tight seal.



Single-tube flowhead

The outlet fitting for a single-tube flowhead is not an integral component of the O_2 flowmeter. The outlet fitting is a separate component that includes an o-ring seal and is held in place with two u-clips.



3. To remove the Air flowmeter module:

a. Remove the screw located on the side of the Air flowmeter module.

b. Hold the flowmeter module with the flowtubes facing you.

c. Grasp the outer modules at the bottom of the regulator manifold and push the left module away from you until the u-clip pops off and the module separates from the other assemblies.

d. Pull the modules sideways to separate them at the top.
Save the u-clip, spacer tube, and the o-ring for reassembly.

4. To remove the O_2 or N_2O flowmeter module:

a. Set the O_2 and N_2O needle valves to their maximum position (counterclockwise).

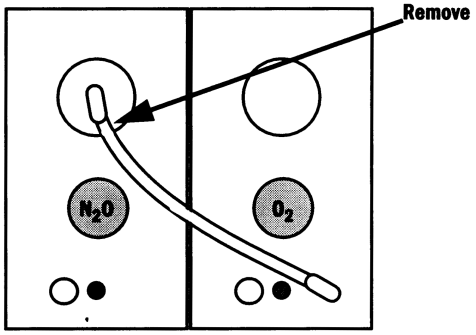
b. Loosen the set screws on the N_2O knob, then remove the knob.

c. Loosen the set screws on the N_2O sprocket and the O_2 knob.

d. To remove, grasp the O_2 knob/sprocket, N_2O sprocket, and chain as an assembly. Remove as an assembly.

e. Remove the spacer from the N_2O needle valve spindle.

f. Remove the pilot tube going to the balance regulator.



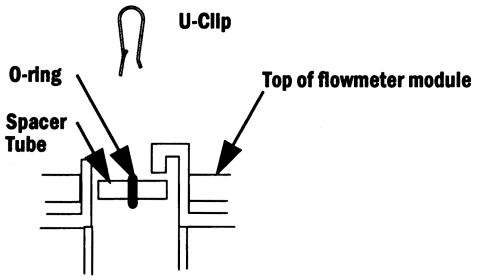
g. The O_2 and N_2O flowmeter modules are held together by a single screw. Remove the screw located on the side of the O_2 flowmeter module.

h. Hold the flowmeter modules with the flowtubes facing you.

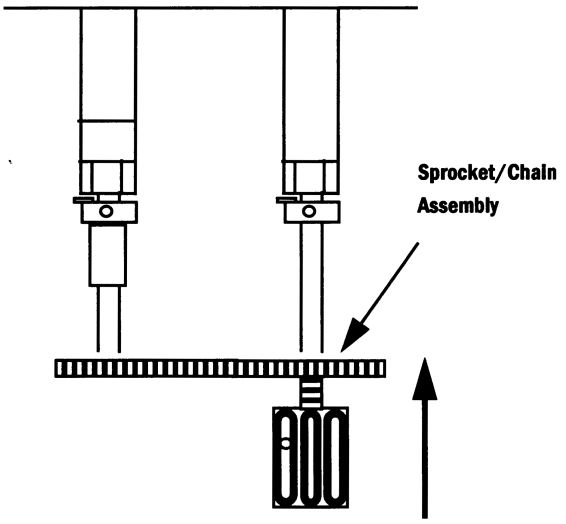
i. Grasp the modules at the bottom of the regulator manifolds and push the left module away from you until the N_2O module separates from the O_2 module.

j. Pull the modules sideways to separate them at the top.
Save the u-clip, spacer tube, and the o-ring for reassembly.

5. To reassemble the flowmeter modules, perform the previous steps in reverse order.
Note: The u-clips must be reinstalled with the barbed leg to the left as viewed from the front.



6. Install the screw through the O_2 flowmeter module to locks the O_2 and N_2O flowmeter modules together.
7. Reattach the pilot tube that goes to the balance regulator.
8. Install the flowhead into the machine. Reconnect the tubing and the O_2 supply switch harness.
9. Confirm needle valve calibration (Section 5.3).
10. Install the spacer on the N_2O needle valve stem.
11. Install the chain on the O_2 knob/sprocket assembly and the N_2O sprocket.
12. Install the chain and sprockets on the needle valve stems as an assembly. Do not tighten the set screws.



13. Install the N_2O knob. Snug one set screw to hold the knob in place.
14. Perform the link system calibration (Section 5.4).
15. Install the flowmeter panel shield.
16. Perform the checkout procedure (Section 3).

9.7.5 Replace flowmeter frame

1. Remove the front flowmeter panel shield (Section 9.7.1).
2. Remove the complete flowmeter head (Section 9.7.3).
3. Separate the flowmeter modules as required (Section 9.7.4).
4. Remove the flowtubes (Section 9.7.2). Keep all the parts for reassembly.
5. Remove the gas identification panel by removing the two screws at the back of the frame. Keep all the parts for reassembly.

6. Remove the flowmeter frame by loosening the four mounting screws at the back of the regulator manifold.

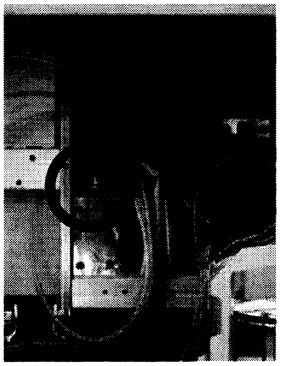
   Note: There is a retainer in each screw location that keeps each screw within the manifold.

7. To reassemble, perform the previous steps in reverse order.
8. If replacing O_2 or N_2O frames, perform the link system calibration (Section 5.4).
9. Perform the checkout procedure (Section 3).

9.7.6 Replace O_2 supply switch

The O_2 supply switch is located on the O_2 flowmeter's regulator module.

1. Remove the upper rear panel (Section 9.2).
2. Remove the two mounting screws from the O_2 supply switch.



3. Pull the O_2 supply switch out of the regulator manifold.
4. Install the replacement O_2 supply switch.
5. Tighten the screws.
6. Disconnect the leads from the old switch and reconnect them to the new switch.
7. Adjust the alarm threshold for the new O_2 supply switch, as explained in the checkout procedure below (Section 9.7.7).
8. Replace the rear panel.
9. Perform the checkout procedure (Section 3).

9.7.7 Checkout procedure for O_2 supply switch

1. Remove the upper rear panel (Section 9.2).
2. Attach a gauge to the O_2 primary regulator test port. (On pipeline only machines, attach the gauge to a 6-mm O_2 port).
3. Adjust the O_2 flow control to minimum flow (clockwise).
4. Install an O_2 cylinder and open the cylinder valve (for pipeline only, connect O_2 pipeline source).
5. Turn the system on.
6. Close the cylinder valve (disconnect pipeline from source) and watch the test gauge as the O_2 pressure bleeds down slowly.

   Note: The "No O_2 pressure" alarm should occur between descending pressure of 221–193 kPa (32–28 psi).
7. If adjustment is required, set the adjustment screw so that the "No O_2 pressure" alarm occurs at 207 ±7 kPa (30 ±1 psi).
8. Disconnect the gauge and plug the test port
9. To reassemble, perform the previous steps in reverse order.
10. Perform the checkout procedure (Section 3).

9.7.8 Replace secondary regulator manifold or balance regulator manifold

1. Remove the front flowmeter panel shield (Section 9.7.1).
2. Remove the complete flowmeter head (Section 9.7.3).
3. Separate the flowmeter modules (Section 9.7.4).
4. Remove the flowmeter frame from the regulator manifold by removing the four screws at the rear of the regulator manifold (no need to remove flowtubes).
5. Remove the needle valve from the regulator manifold:
   a. Unscrew the complete assembly together (stop collar, needle valve).
   b. Replace the o-ring if necessary.
6. Screw the needle valve into the new regulator manifold.
7. Remove the plugs and balance regulator elbow fitting (and O_2 supply switch if an O_2 module) from the old regulator manifold.
8. Install the plugs and balance regulator elbow fitting (and O_2 supply switch if an O_2 module) into the new regulator manifold (pull on the plugs and fittings to ensure that they are locked into the manifold).
9. Reinstall the flowmeter frame to the regulator manifold.
10. Reinstall all the flowmeter modules to the flowmeter head.
11. Reinstall the flowmeter head (Section 9.7.4).
12. Do the necessary calibrations (Section 6).

Necessary calibrations	Section
Secondary Regulator	5.2
O_2 minimum flow	5.3.1
Link system	5.4

13. Reinstall the front flowmeter panel shield.
14. Perform the checkout procedure (Section 3).

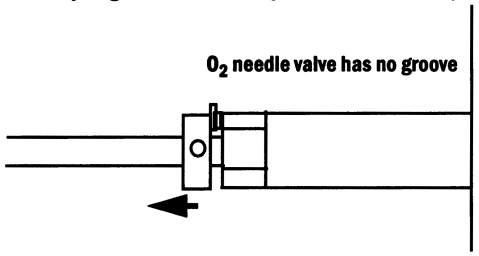
9.7.9 Replace O_2 or N_2O needle valves (on machines with N_2O)

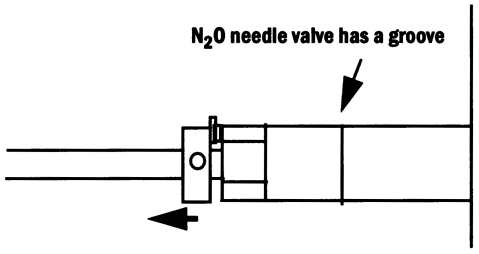
For machines without N_2O, refer to Section 9.7.10 for replacing the O_2 needle valve.

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the front flowmeter panel shield (Section 9.7.1).
4. Set the O_2 and N_2O needle valves to their minimum position.
5. Loosen the set screws on the N_2O knob, then remove the knob.
6. Loosen the set screws on the N_2O sprocket and the O_2 knob.
7. To remove, grasp the O_2 knob/sprocket, N_2O sprocket, and chain as an assembly. Remove as an assembly.
8. Remove the spacer from the N_2O needle valve spindle.
9. Loosen the set screws on the needle valve stop collar for the needle valve that is being replaced.
10. Remove the stop collar.
11. To remove the needle valve from the flowmeter block, turn the needle valve counterclockwise with a 16-mm wrench.
12. To install the new needle valve, turn it clockwise and tighten it with the wrench.

    Note: Be sure the o-ring is properly located on the tip of the needle valve.

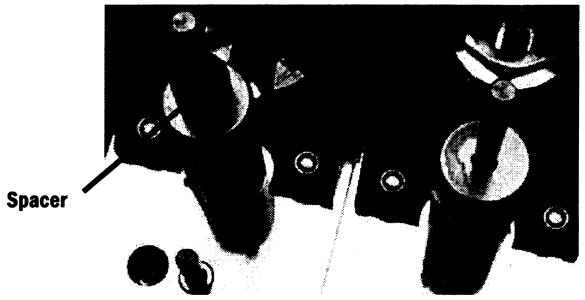
⚠ WARNING The O_2 and N_2O needle valves are not the same. Patient injury can result if the wrong needle valve is installed in the flowmeter block. You can identify the N_2O needle valve by a groove located just below the top brass hex.



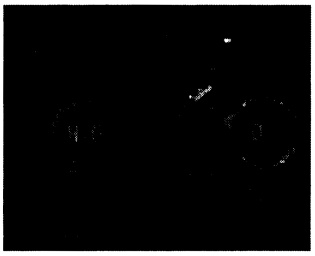


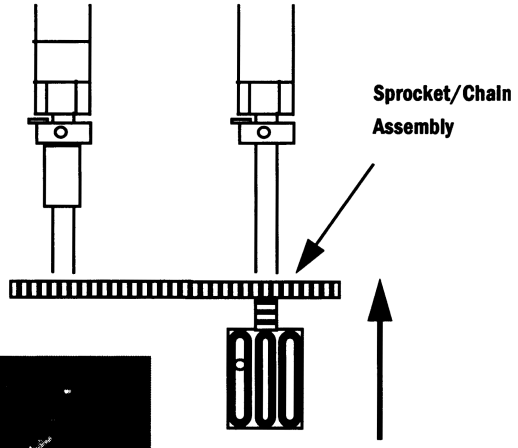
13. Install the stop collar on the new needle valve. Do not tighten the set screws.
14. Perform the needle valve calibration (Section 5.3).

15. After calibrating the needle valve, put the spacer the N_2O needle valve spindle.



16. Put the chain on the O_2 knob/sprocket assembly and the N_2O sprocket.
17. Install the chain and sprockets on the needle valve spindles as an assembly. Do not tighten the set screws.





18. Install the N_2O knob. Do not tighten the set screws.
19. Perform the link system calibration (Section 5.4).
20. Install the flowmeter panel shield.
21. Perform the checkout procedure (Section 3).

9.7.10 Replace an Air needle valve on all machines or an O_2 needle valve on machines without N_2O

For machines with N_2O, refer to Section 9.7.9 for replacing the O_2 needle valve.

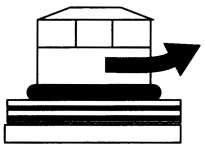
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the front flowmeter panel shield (Section 9.7.1).
4. Loosen the set screws on the flow control knob and remove the knob.
5. Loosen the set screws on the stop collar and remove the collar.
6. If equipped, remove the maximum flow stop collar.
7. Using a 16-mm wrench, remove the needle valve by turning it counterclockwise.
8. Install the new needle valve and tighten.

   Note: Be sure the o-ring is properly located on the tip of the needle valve.
9. If equipped, install the maximum flow stop collar (do not tighten).
10. Install the stop collar (do not tighten the screws).
11. Install the flow control knob on the shaft. Tighten one set screw to snug.
12. Reconnect the gas supplies.
13. Perform the flow control stop procedures explained in:
    - Section 5.3.1 for O_2.
    - Section 5.3.3 for Air.
14. Install the flowmeter panel shield.
15. Perform the checkout procedure (Section 3).

9.8 Service vaporizer manifold parts

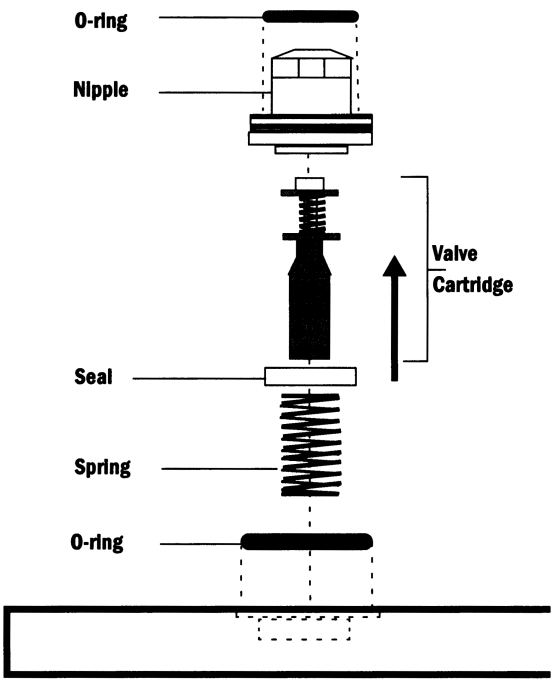
9.8.1 Repair manifold port valve

1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Using a 14-mm wrench, carefully remove the valve nipple (threaded).



4. Disassemble as necessary to replace parts. The following illustration shows the parts.

Note: The port valve replacement kit includes the valve cartridge assembly and the seal. The kit does not include o-rings.



5. When installing a new valve cartridge assembly into the vaporizer manifold, put a light coat of Krytox on the bottom portion of the cartridge. The bottom portion of the cartridge is defined as the brass surface that is inserted in the lower spring. **Note:** Do not apply Krytox to the valve seal.
6. Verify that the parts are free of dust and dirt.
7. To reassemble, perform the previous steps in reverse order.
8. Complete the port valve checkout procedure described below (Section 9.8.2).

9.8.2 Checkout procedure for manifold port valve

Use the Vaporizer Manifold Valve Test Tool to perform the checkout procedure for the manifold port valve. This tool and test procedure are intended for use only when the valve cartridge assembly is replaced.

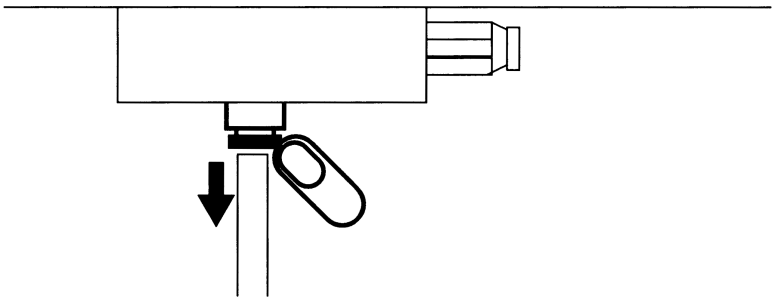
Note This replacement and test procedure is a service action and is not part of the maintenance program.

1. Set the system switch to Standby.
2. After replacing the valve cartridge assembly, remove the vaporizer port o-ring.
3. Attach the valve tester to the top of the valve by sliding the bottom of the tester onto the o-ring groove.
4. Tighten the tester screw down onto the valve until the screw bottoms out on the top of the valve. The tester o-ring should create a seal with the top of the valve.
5. Remove the upper rear panel (Section 9.2).
6. Remove the inlet tube from the vaporizer manifold.
7. Set the SCGO Selector switch to ACGO.
8. Test the negative low-pressure leak-test device:
   a. Put you hand on the inlet of the leak-test device. Push hard for a good seal.
   b. Remove all air from the bulb.
   c. The bulb should not inflate in less than 60 seconds.
9. Attach the negative low-pressure leak-test device to the ACGO outlet.
10. Remove all air from the bulb. The bulb should not inflate in less than 45 seconds.
11. Remove the valve tester.
12. Reassemble the inlet tube, vaporizer port o-ring, and the upper rear panel.
13. Conduct a negative low-pressure leak test on the system (Section 3.9.1).

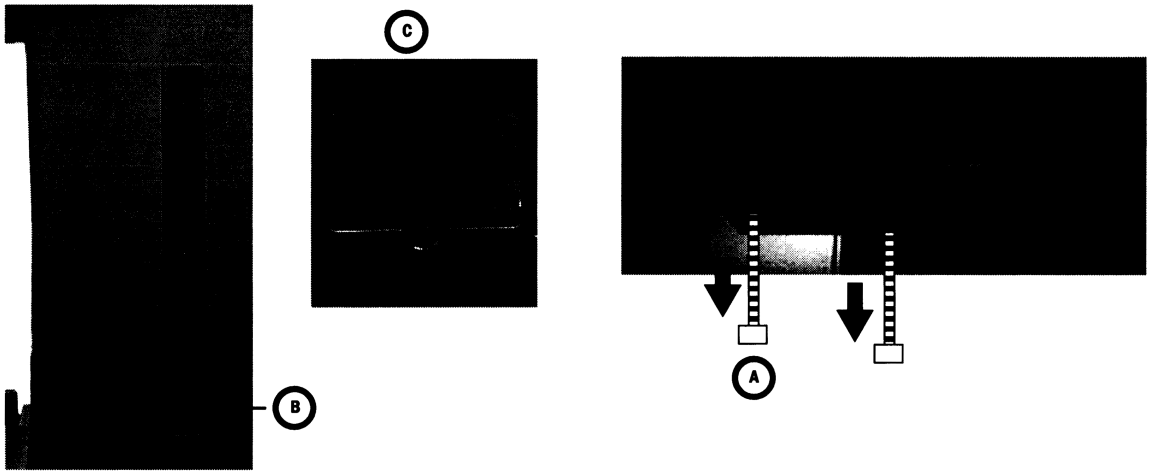
⚠ WARNING If the valve test tool is not removed before flowing gas through the system, pneumatic head damage could result.

9.8.3 Replace vaporizer manifold check valve

1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Remove the upper rear panel.
4. Disconnect the tubing from the valve block.

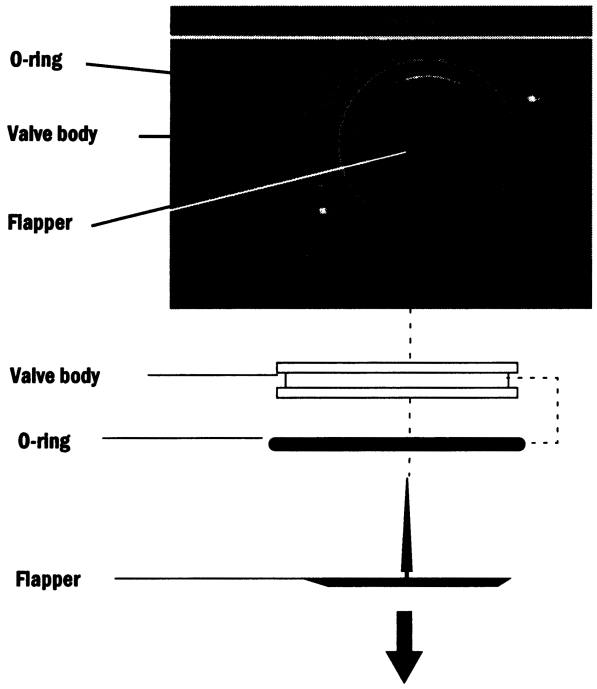


5. Remove the valve block.
   - To access the left-hand mounting screw (**A**), remove the right (viewed from front) side panel (**B**).
   - The right-side extrusion include an access hole (**C**) for removing the left-hand mounting screw.
   - **Note:** For early production machines that do not have an access hole in the extrusion, you must remove the vaporizer manifold to remove the valve block.



Note The valve body, o-ring, and flapper do not come out with the block. They stay intact at the bottom of the vaporizer manifold.

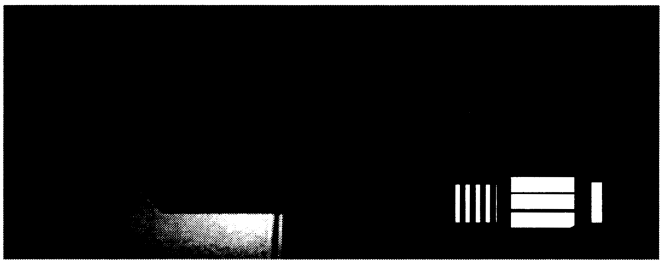
6. Pull the flapper out of the valve body.



7. Using a hex wrench, put the wrench through one of the holes of the valve body and pull down to remove the valve body and o-ring.
8. Verify that parts are free of dust and dirt.
9. Replace the flapper by inserting the flapper stem and gently pulling the stem until the flapper secures to the valve body.
10. Lightly lubricate the o-ring with Krytox.
11. Place the lubricated o-ring on the valve body port at the bottom of the manifold.
12. Gently install the valve body in the manifold:
    - Check that the o-ring makes a good seal between the manifold and the valve body.
    - Check that the flapper valve makes solid contact with the valve body.
13. Install the valve block.
14. Reconnect the tubing to the valve block. Pull on the tube to ensure that it is locked in the fitting.
15. Install the vaporizer front panel.
16. Perform the checkout procedure (Section 3).

9.8.4 Replace vaporizer pressure relief valve

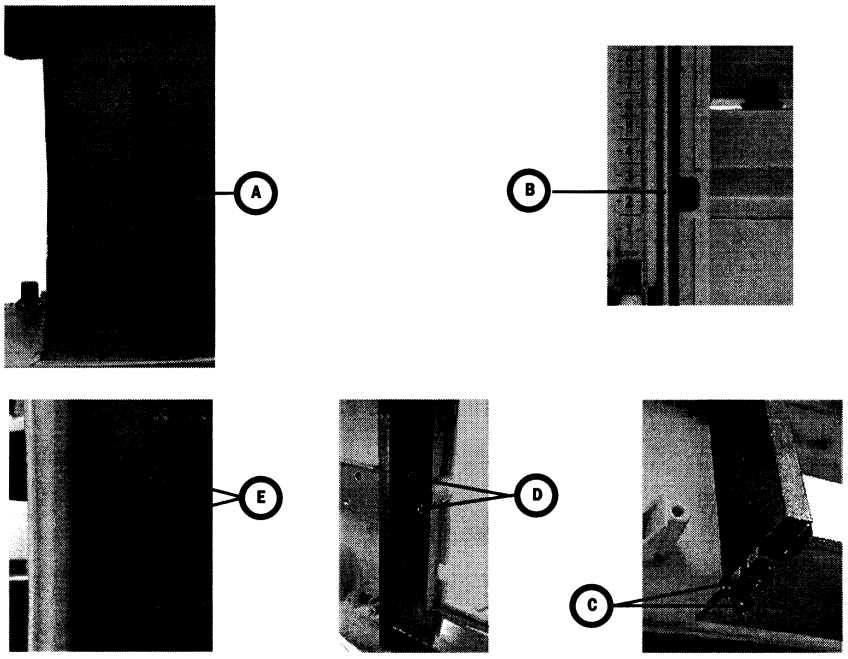
1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Remove the upper rear panel (Section 9.2).
4. Using a 13mm open ended wrench, remove the vaporizer pressure relief valve by turning counterclockwise.



5. Verify that the parts are free of dust and dirt.
6. Install a new vaporizer pressure relief valve.
7. To reassemble, perform the previous steps in reverse order.
8. Perform the checkout procedure (Section 3).

9.8.5 Replace vaporizer manifold

1. Remove the upper rear panel (Section 9.2).
2. Remove the front flowmeter shield (Section 9.7.1).
3. Remove the right side panel (**A**).
4. From the front of the machine, remove the screw (**B**) at the right upright of the flowhead bezel.
5. From the back of the machine, remove the two screws (**C**) that hold the vaporizer manifold vertical support to the flowhead bracket.
6. From the back of the machine, remove the two screws (**D**) that hold the vertical support to the vaporizer manifold.
7. Remove the vertical support from the machine.
8. While holding the vaporizer manifold, remove the two screws (**E**) at the right-hand extrusion to release the manifold.

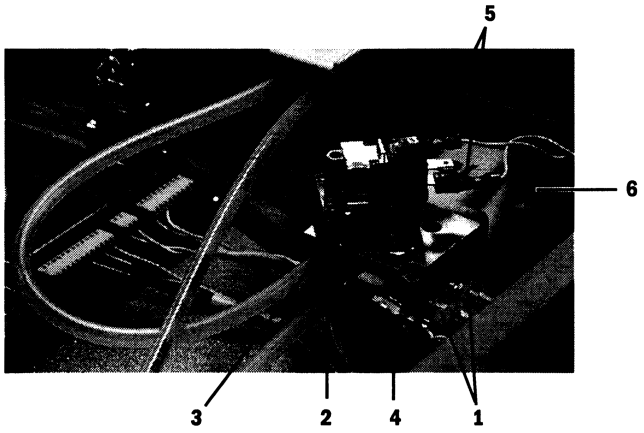


9. Install the new vaporizer manifold in reverse order. Do not fully tighten the screws until they are all in place.
   - Attach the new manifold to the right-hand extrusion (**E**).
   - Attach the vertical support to the vaporizer manifold (**D**).
   - Attach the bottom of the vertical support to the flowhead bracket (**C**).
   - Attach the vertical support to the front bezel (**B**).
10. Tighten the mounting screws in the following order: **E**, **D**, **C**, **B**.
11. Reassemble the machine.
12. Perform the checkout procedure (Section 3).

9.9 Replace ACGO selector switch

Removal

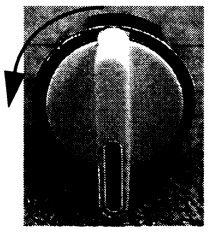
1. Remove the tabletop (Section 9.3).
2. Clip the tie wraps (**1**) from the outlet barb fittings at the side of the switch.



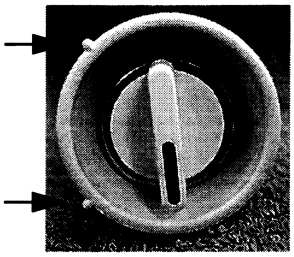
3. Disconnect the fresh gas (**2**) and flush (**3**) tubes at the back of the switch.
4. Disconnect the wires from the ACGO mode microswitch (**4**) at the back of the selector switch.
5. Disconnect the wires from the flush pressure switch (**5**) on top of the selector switch.
6. Set the ACGO selector switch to ABS.
7. Back out the selector switch mounting screws (**6**) until the tips are flush with the face of the mounting casting.
8. While pushing the selector knob toward the machine and holding it steady, push the valve body toward the knob and rotate it counterclockwise to separate the valve body from the knob assembly.
9. Remove the knob assembly and protective shroud from the machine.
10. Remove the valve from the silicone output tubes.

Replacement

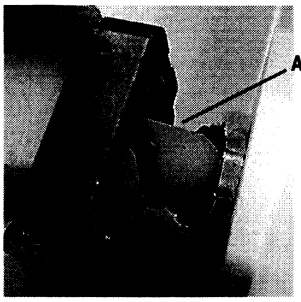
1. Remove the knob assembly from the valve body.
2. Back out the selector switch mounting screws until the tips are flush with the face of the mounting casting.
3. Guide the outlet fittings of the valve body into their respective silicone tubes.
4. Hold the selector knob with the indicator mark facing down. Turn the chrome collar to its maximum counterclockwise position (as viewed from the front).



5. Place the shroud over the knob and guide the assembly into the pan opening.
6. Ensure that the indicators on the shroud align with label on the pan and the alignment tab mates with the alignment hole in the pan.



7. While holding the knob assembly steady against the pan, place the valve assembly over the knob actuator. Using moderate force press the two assemblies together. The knob should rotate to the ACGO position.



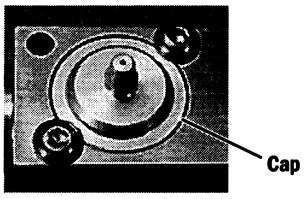
8. While continuing to force the assemblies together, rotate the knob assembly to the ABS position. The assemblies should snap into place.
9. Verify proper alignment of the knob with the setting indicators. Tighten the mounting screws evenly to secure the switch assembly to the pan.
10. Secure the outlet tubing with tie wraps.
11. Connect the fresh gas and flush gas tubing. Pull on the tubing to ensure that it is locked in the fitting.
12. Reconnect the wires to the ACGO mode microswitch at the back of the valve (top two terminals).
13. Reconnect the wires to the flush pressure switch at the top of the valve (upper and lower terminals).
14. Replace the tabletop.

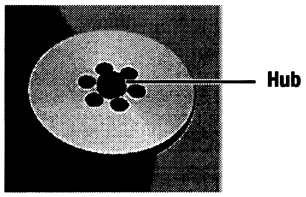
Test procedure

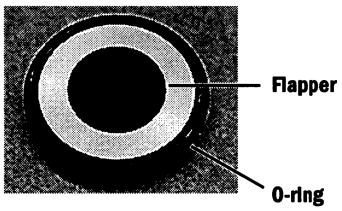
1. Confirm that flush flow and 5 L/min fresh gas flow are diverted to the ACGO port and the ABS in the respective knob positions.
2. Confirm that the ventilator display indicates ACGO mode when the valve is set in the ACGO position.
3. Test the function of the flush pressure switch. (Section 4.10.2, "*Display Discrete I/O Signals*")
4. Perform the low-pressure leak test (Section 3.9).
5. Perform the checkout procedure (Section 3).

9.10 Clean or replace ACGO port flapper valve

1. Remove the tabletop (Section 9.3).
2. Remove the ACGO cap mounting screws.
3. Remove the cap.
4. Examine the flapper and disk for obstructions or debris. Clean with isopropyl alcohol if necessary; retest.
5. If leak persists, replace the flapper.
   - Remove the flapper from the check valve disk.
   - Clean the new flapper with isopropyl alcohol.
   - Apply a drop of isopropyl alcohol to the center hub of the new flapper.
   - Before the alcohol evaporates, align the center hub of the new flapper with the center hole of the check valve disc.
   - While pressing the flapper against the disc, use your fingernail to help pull the hub through the disc from the other side.







6. Lubricate the o-ring sparingly with Krytox (do not get Krytox on the flapper).
7. Insert the flapper assembly into the ACGO outlet with the flapper up.
8. Replace the cap.

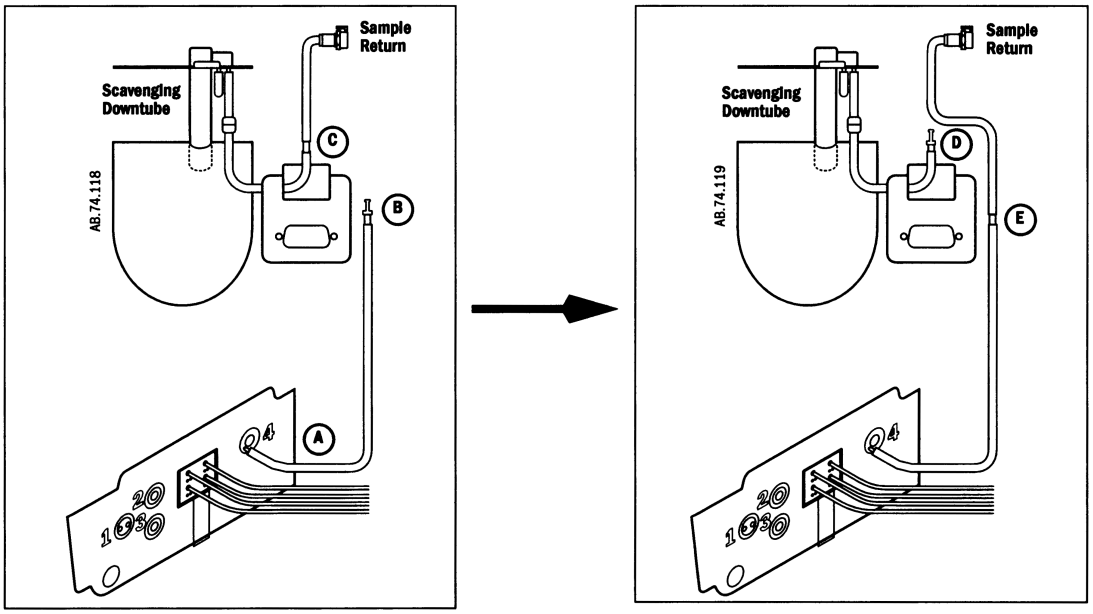
9.11 Reconfigure sample gas return line

Note In the U.S., it is not permitted to return sample gas to the breathing circuit.

Outside the U.S., consult with hospital guidelines on filtering of re-breathed gas before allowing the sample gas return line to be reconfigured.

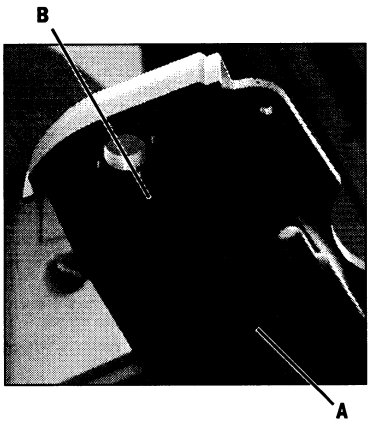
Procedure Sample gas return is directed to the scavenging system as a factory default. Perform the following to reroute the sample gas back to the breathing system.

1. Remove the tabletop.
2. Port 4 (**A**) of the ABS breathing system is connected to the expiratory circuit, downstream of the expiratory check valve. As a factory default, Port 4 is plumbed with a length of tubing that is plugged (**B**) at the far end.
3. Remove the plug from the tube.
4. Find the sample return line at the left-rear corner of the pan assembly. The sample return line includes an inline connector (**C**) at the point where the sample line goes down into the vent engine housing.
5. Separate the scavenging tube, removing the inline connector from the portion of the tube that extends into the vent engine housing. Plug the open end of the scavenging tube (**D**) with the plug removed above.
6. Insert the inline connector from the sample return port into the open end of the return tube (**E**) to Port 4. Pull on the connector to ensure that it is securely connected.
7. Replace the tabletop.
8. Perform the checkout procedure (Section 3).

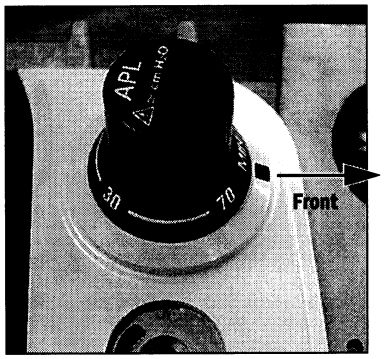


9.12 Replace the APL valve

1. Remove the ABS breathing system.
2. The APL valve is held in place with a spring and a retainer (**A**) that snaps into a recess in the lower body of the APL valve. To release the retainer, place an appropriately sized straight blade screwdriver into the housing cutout (**B**). Twist the screwdriver to release the retainer.



3. Place the new APL valve into position with the setting indicator facing to the front of the machine.
4. Place the spring into the retainer.
5. While holding the APL valve tight to the housing, snap the spring and retainer onto the valve body from below.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).

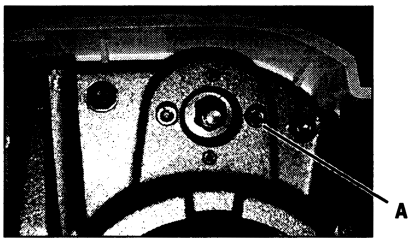


9.13 Replace the bag support arm

1. Remove the ABS breathing system from the machine.

Note: To help prevent the bag arm mounting from loosening, current production machines use socket head screws and flat washers to secure the bag arm to the casting instead of Posidriv screws and lockwashers. Refer to the parts section for stock numbers.

2. From the underside of the casting, remove the hardware (**A**) that holds the arm in place.
   - If either of the pins (see below) remain in the casting, remove them from the casting.

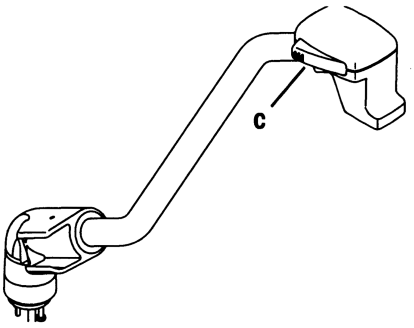


3. Install the new bag support arm assembly.
   - Position the bag arm over mounting pattern of 4 small holes in the support casting. The arm should extend towards the front of the machine. Align the two pins (**B**) extending from the base of the bag arm assembly, with two of the small holes in the casting that are in line with the APL valve.

   - Lower the bag arm, pushing the two pins into the holes.
   - From the underside of the casting, secure the bag arm with two M3x20 socket head screws and flat washers.
4. Test the force required to swing the bag arm from side to side and adjust if necessary.

Note: The adjustment nut is initially set so that 5-mm of exposed thread extends from the adjusting nut. With use, the force required to move the arm increases and may require readjustment.

The force is adjusted by turning the lock nut (8-mm socket) which is accessible from underneath the support casting. Turn clockwise to increase the force and counterclockwise to reduce the force.



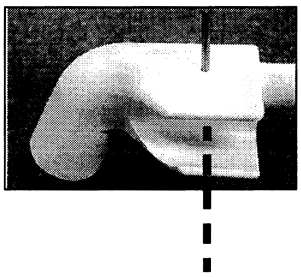
   - Swing the bag arm sideways through the 90 degree arc permitted by its internal stop.
   - Adjust to just enough friction to prevent the bag arm from swinging sideways as the bag height is being changed. The bag arm height is changed by squeezing the lock release lever (**C**) at the free end of the bag arm and rotating it to the desired position.
5. Replace the ABS breathing system.

9.13.1 Servicing the bag support arm

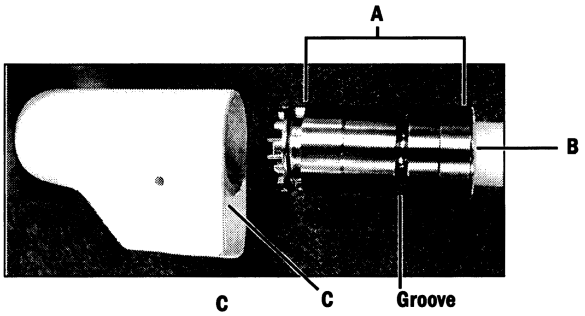
Service parts for the bag support arm include the upper and lower assemblies.

To replace either assembly:

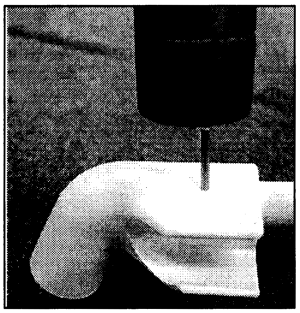
1. Remove the bag support arm from the machine (Section 9.13).
2. To separate the upper assembly from the lower assembly, use a small (2.5-mm) pin punch from the bottom to drive the dowel pin up and out.



3. To assemble the bag arm, apply a light coat of Krytox to the area of the upper arm (**A**) that extends into the lower arm (including the dowel pin groove).

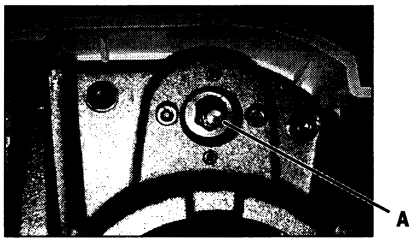


4. Insert the upper assembly into the lower assembly. Align the surface (**B**) of the upper assembly with the surface (**C**) of the lower assembly.
5. Insert the dowel pin into the hole (from the top side as shown). Drive the dowel pin into the bag arm until it is flush with the top surface.



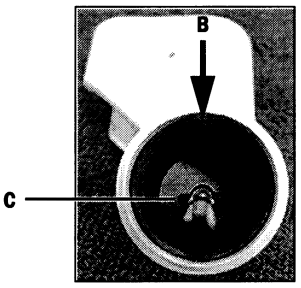
9.13.2 Replace friction pad in lower bag arm assembly

1. Remove the ABS breathing system from the machine.
2. Using an 8-mm socket, remove the nut (**A**), shoulder washer, and spring from the lower assembly.

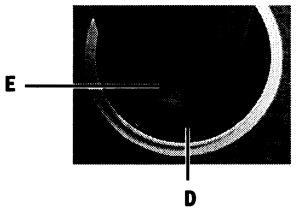


3. Lift the bag support arm off of the swivel post. Remove the old friction pad.
4. Wipe any residue and friction particles from the post.
5. Insert a new friction pad into the base. Keep approximately 1 mm of space between the end of the pad and the bottom of the base.

   Note: Align the friction pad gap with the seam (**B**) in the base. Position the retaining screw so the pin (**C**) at the base is perpendicular to the seam.



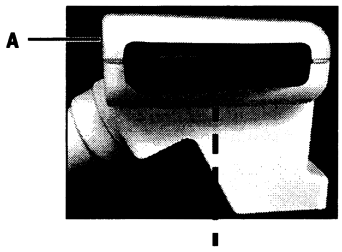
6. With the bag support arm facing forward, place the base of the arm over the swivel post. Ensure that the slot in the base (**D**) engages the tab (**E**) on the swivel post.
7. Replace the spring, shoulder washer and nut. Tighten the nut until 5 mm of thread extends beyond the nut.



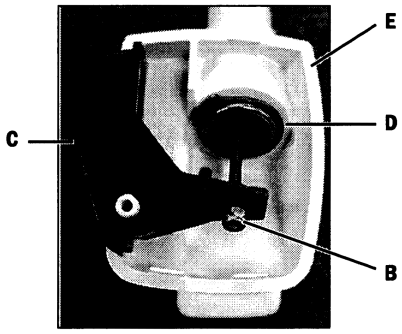
8. Follow the procedure in Section 9.13 to adjust the force required to swing the bag arm from side to side.

9.13.3 Replace bag port housing

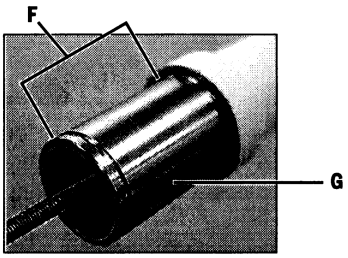
1. Remove the bag support arm cover (**A**) – screw and lockwasher from below.



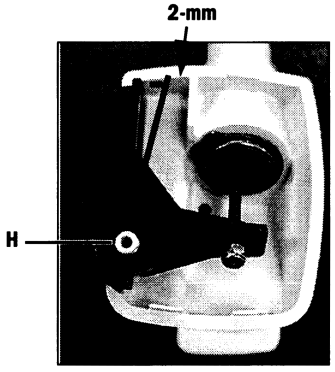
2. Remove nut (**B**) to remove the release lever (**C**).
3. Remove the retaining ring (**D**).
4. Slide the bag port housing (**E**) off the end of the bag support arm.



5. Before installing the new bag port housing, clean and lubricate sparingly with Krytox the exposed metal end (**F**) and the guide slot (**G**) of the bag support arm.

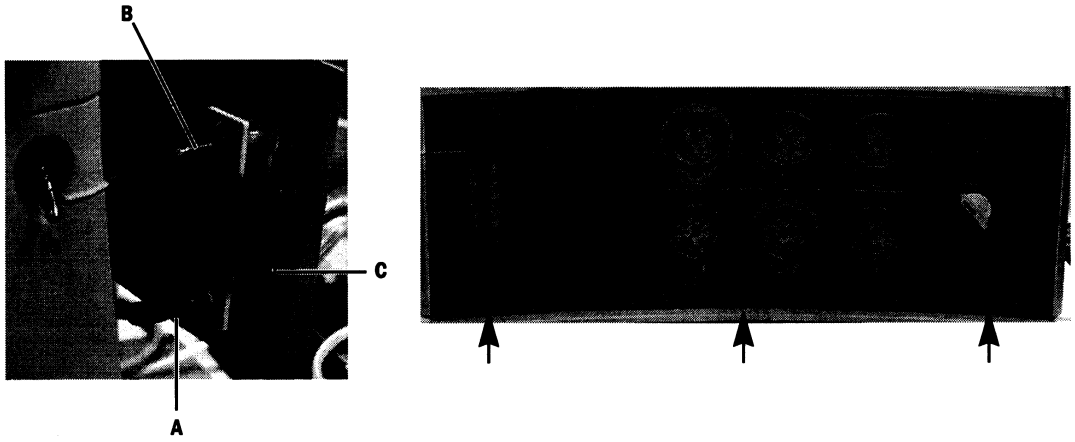


6. Slide the new bag port housing onto the bag arm. Secure it with the retaining ring.
7. Lubricate sparingly with Krytox the pivot boss (**H**) before replacing the release lever.
8. After replacing the release lever, adjust the mounting nut so that a 2-mm gap remains between the lever and housing when the release lever is fully depressed.
9. Replace the bag arm cover.



9.14 Replace auxiliary O_2 flowmeter

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the tabletop (Section 9.3).
4. Remove the adjustment knob from the flowmeter; pull forward.
5. Remove the gauge panel mounting screws and move the panel forward to access the flowmeter.



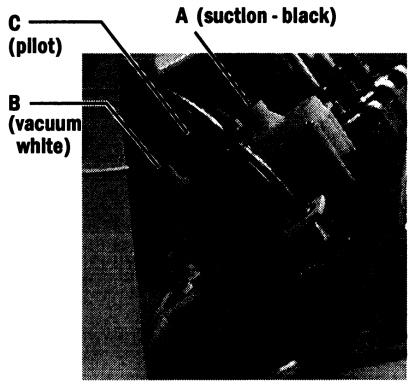
6. Disconnect the inlet tube fitting (A).
7. Disconnect the tube (B) from the outlet fitting.
8. Remove the four screws (C) that hold the flowmeter mounting bracket to the front panel.
9. Transfer the mounting bracket to the new flowmeter.
10. Reassemble in reverse order.
11. Perform the checkout procedure (Section 3).

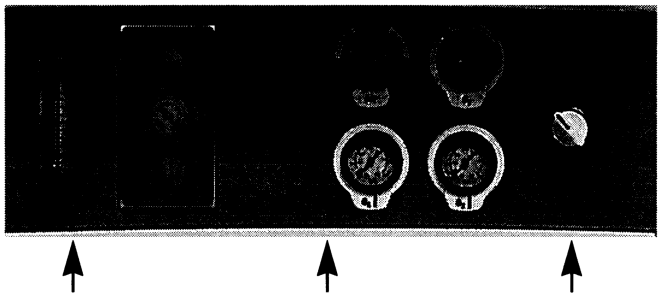
9.15 Replace the suction control module

The suction control module can be replaced by removing the front panel, along with the ABS and the tabletop, to gain access. Alternatively, if the situation warrants, the suction control module can be accessed by removing the rear panel.

9.15.1 Front panel method

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the tabletop (Section 9.3).
4. Remove the gauge panel mounting screws and move the panel forward to access the suction control module.

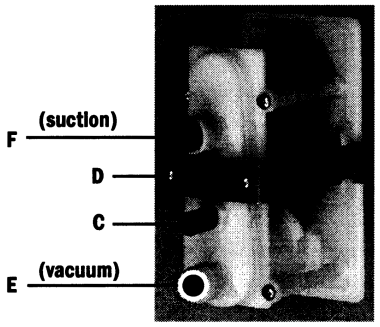


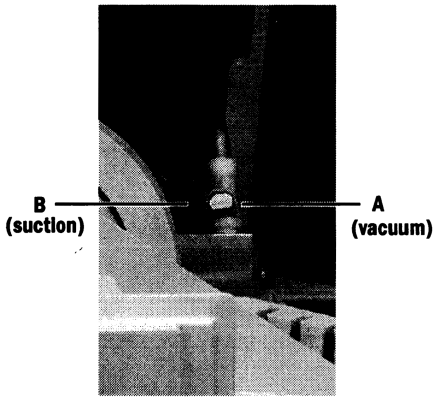


5. Disconnect the tubing from the suction control module.
   - Tube (**A**) from overflow safety trap (suction).
   - Tube (**B**) from vacuum source.
   - If venturi drive, tube (**C**) from pilot valve adapter.
6. Remove the two mounting screws that hold the suction control module to the mounting bracket.
7. Transfer the mounting bracket to the new suction control module.
8. Reassemble in reverse order.
9. Perform the checkout procedure (Section 3).

9.15.2 Rear panel method

1. Lower the upper rear panel (Section 9.2).
2. Disconnect the white (**A**) vacuum and black (**B**) suction fittings from the rear panel. Do not remove the tubing from the regulator.
3. If you are replacing a venturi drive suction control module, disconnect the tube (**C**) from the pilot valve adapter.



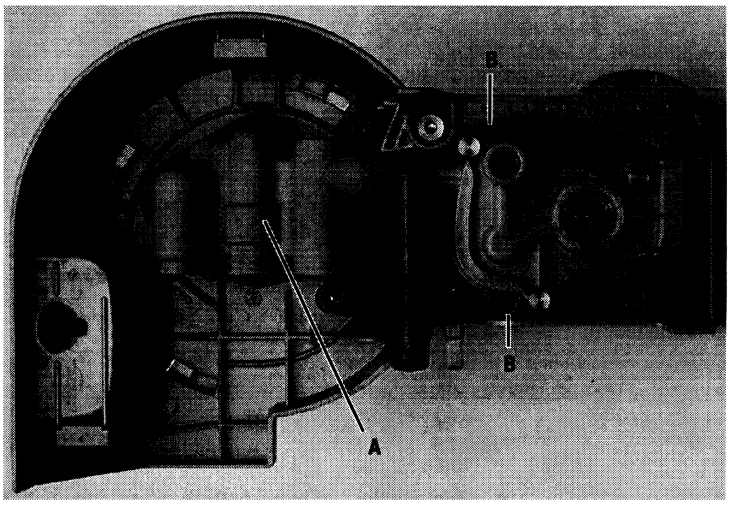


4. Remove the two screws (**D**) that hold the suction control module to the mounting bracket.
5. Remove the regulator assembly from the front panel.
6. Transfer the tubing to the new regulator:
   - Attach the vacuum source tube (white fitting) to the lower connector (**E**).
   - Attach the suction tube (black fitting) to the upper connector (**F**).
7. Guide the tubes into the front panel opening.
8. While holding the regulator assembly against the front panel, attach the retaining bracket to the regulator. Tighten the screws to secure the regulator assembly.
9. If applicable, attach the control port tube to the pilot valve adapter (**C**).
10. Attach the vacuum and suction fitting to the rear panel manifold.
11. Replace the rear panel.
12. Perform the checkout procedure (Section 3).

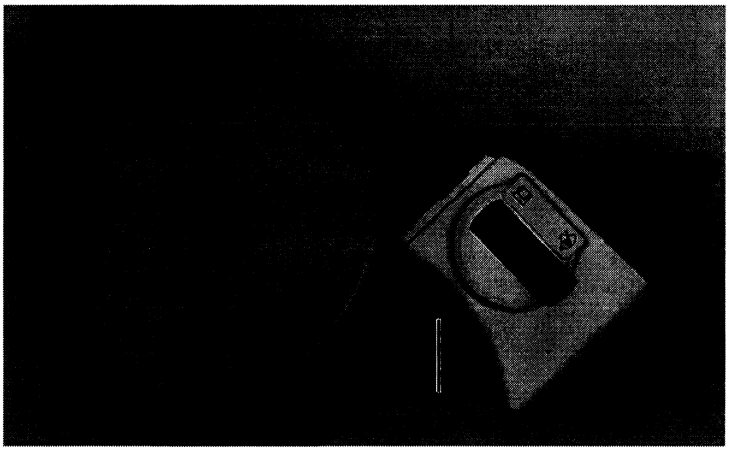
9.16 Replace ABS breathing system components

9.16.1 Replace Bag/Vent switch assembly

1. Remove the ABS breathing system.
2. From the underside, remove the bellows base manifold (**A**) and fully loosen the two captive screws (**B**) at the bag port side of the APL/BTV manifold.



3. From the topside, rotate the Bag/Vent switch cartridge counterclockwise until the Bag/Vent switch outlet port (**C**) clears the bellows housing.

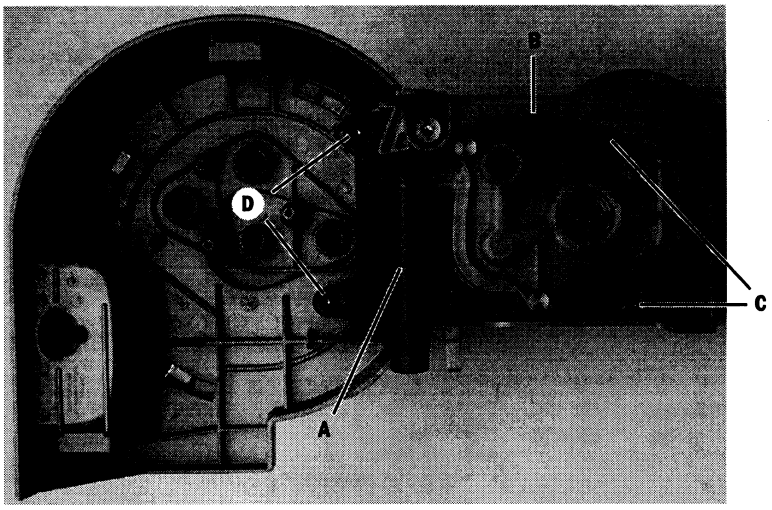


4. Lift out the Bag/Vent switch cartridge from the housing.
5. Replace the Bag/Vent switch cartridge in reverse order.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).

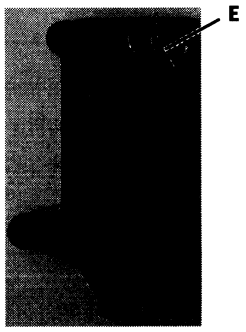
9.16.2 Replace bellows base latch assembly

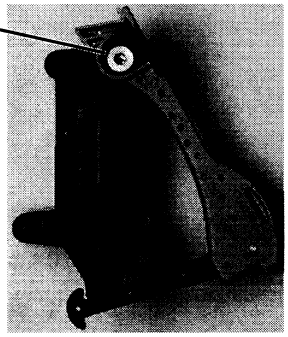
To replace the latch assembly, you must disassemble the bellows base assembly to the point where you can remove the guide (**A**) and latch assembly (**B**) as a unit.

1. Remove the Bag/Vent switch cartridge (Section 9.16.1).
2. Remove the two remaining screws (**C**) that hold the APL/BTV manifold to the bellows base assembly. Remove the APL/BTV manifol.



3. To remove the guide/latch assembly, remove two mounting screws (**D**) from the underside. Remove two additional mounting screws from the topside. Remove the guide/latch assembly from the bellows base assembly.
4. Separate the latch assembly from the guide assembly.
5. To install the new latch assembly, put the spring (**E**) into place in the guide assembly (long leg down).
6. Place the latch assembly on the guide assembly so that the latch engages the short leg of the spring. Secure the latch assembly (**F**) to the guide assembly.

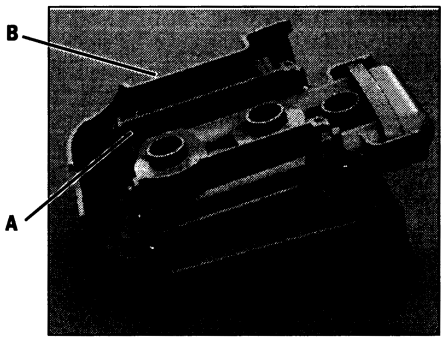


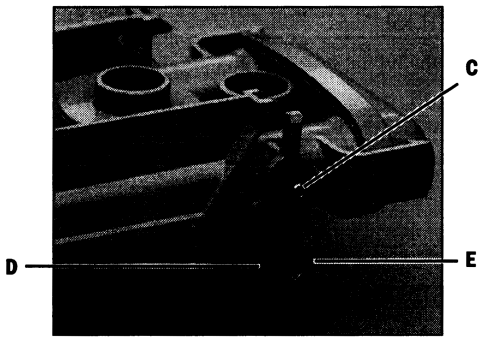


7. Mount the guide/latch assembly into the bellows base assembly.
8. Reassemble the breathing system in reverse order.
9. Perform the checkout procedure (Section 3).

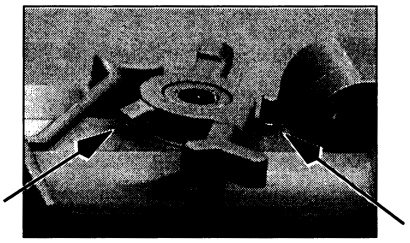
9.16.3 EZchange Canister spring replacement

1. Detach the EZchange module from the machine.
2. Remove the two M3 screws (**A**) that hold the module cover (**B**); set the cover aside.





3. Remove the two M3 shoulder screws (**C**) that fasten the canister latch lever (**D**).
4. Remove the latch lever, the switch actuator lever (**E**) and the spring; discard the spring.
5. Place the new spring on the module (as shown below). Position the switch actuator lever over the spring. Ensure the spring hooks are fully engaged into the posts on the manifold and the actuating lever.



6. Clean any residual Loctite debris from the M3 shoulder screws removed in Step 3.
7. Place the canister latch lever in position. Apply Loctite 242 to the threads of the two M3 shoulder screw threads and secure the canister latch level.
8. Check the switch actuator lever to ensure free movement. If sticking is observed, loosen the M3 shoulder screw approximately 1/8 of a turn until free movement of the switch actuator lever is observed.
9. Install the module cover.
10. Install the EZchange module.
11. Verify that the following message appears on the screen when the absorber canister is released.
    - 'No CO2 absorption' for Aespire machines
    - 'CO2 Absorber Out of Circuit' for Avance and Aisys machines
12. Perform the Preoperative Checkout Procedure (refer to the User's Reference manual).

9.17 Replace casters

⚠ WARNING Replacing a caster requires at least two people to maneuver and tip the machine. Personal injury and/or machine damage is possible if one person attempts this procedure alone.

1. Disconnect all pipeline hoses from the wall and the machine, close all gas cylinders, unplug the power cord, and set the system switch to standby.

⚠ CAUTION Remove the vaporizers before tipping the machine. If a vaporizer is inverted, it must be set to 5% and purged for 30 minutes with a 5 L/min flow. The interlock system prevents purging more than one vaporizer at a time.

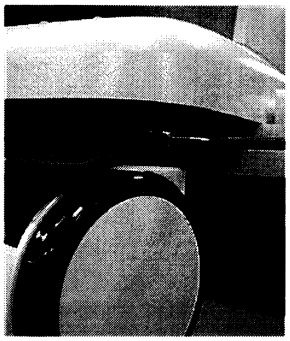
2. Remove the absorber, the vaporizers, gas cylinders, drawers and all auxiliary equipment.

⚠ CAUTION To prevent damage, do not tip the Aespire machine more than 10 degrees from vertical.

3. Block the opposite wheels; then, block up the machine until there is enough room to remove the defective caster.

   To block up the machine, tip and slide blocks under the caster base. Raise both sides evenly until the unit is high enough to remove the caster.

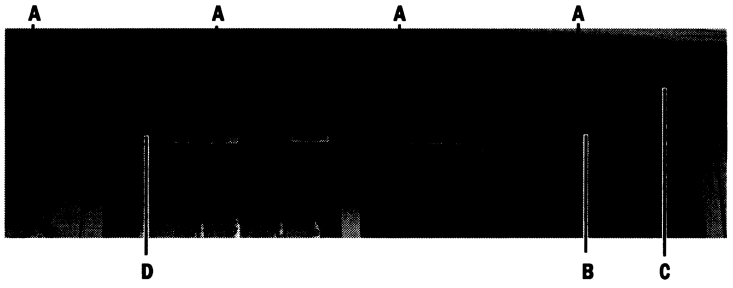
4. The casters are threaded into the base and held with a Loctite compound. Remove the caster with an appropriately sized open-end wrench.



5. If required, clean the threads of the new caster with denatured alcohol.
6. Apply Loctite 242 to the threads of the new caster. Install the caster securely into place.
7. Make sure the caster turns freely.
8. Carefully lower the machine to the floor.
9. Perform the checkout procedure (Section 3).

9.18 Replace task light and switch

Remove the four screws (**A**) that hold the task-light lens to the upper shelf.



9.18.1 To replace the task-light switch

1. Using a small needle-nose pliers, disconnect the switch harness from the task-light circuit board connector (**B**).
2. Remove the two screws (**C**) that hold the switch retainer plate to the upper shelf.
3. Transfer the switch retainer plate to the new switch, counter-sunk side to the outside.
4. Mount the switch to the upper shelf.
5. Remount the task-light assembly. Ensure that the switch harness and the task-light harness wires are positioned in their respective recesses and are not pinched under the task-light lens.

9.18.2 To replace the task-light circuit board

1. Using a small needle-nose pliers,
   - disconnect the switch harness from the task light circuit board connector (**B**).
   - disconnect the task-light harness from the task light circuit board connector (**D**).
2. Slide the task-light circuit board out of the lens.
3. Slide the new task light into the lens, ensuring that the connectors are aligned with the lens cutouts.
4. Plug the task-light harness and the switch harness into their respective connectors on the task-light circuit board. Use a small screwdriver to push the connectors securely into place.
5. Remount the task-light assembly. Ensure that the switch harness and the task-light harness wires are positioned in their respective recesses and are not pinched under the task-light lens.

9.19 Replace the display arm or display cables

Cable replacement requires that you first remove the display arm from the dovetail extrusion.

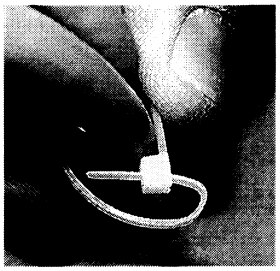
Before replacing the display arm, note the routing of the cables.

After replacing the display arm, ensure that the cables are dressed properly and do not interfere with the motion of the display arm.

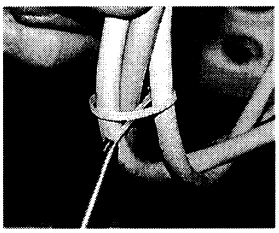
Follow the procedure in Section 9.19.1 for the recommended use of cable ties.

9.19.1 Cable tie installation

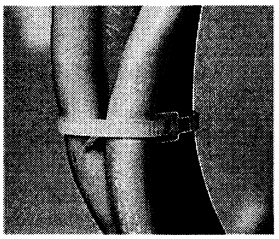
1. Wrap the cable tie around the cables in the indicated position. Start the tail through the clamp as shown.



2. Feed the tail between the cables.



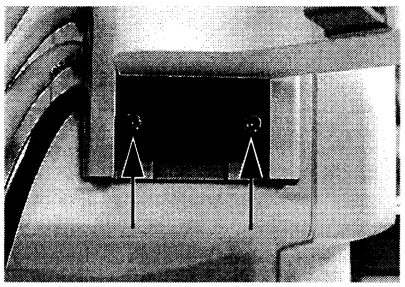
3. Pull the tie tight and cut off the tail below the outer surface of the cables. Do not leave a sharp edge exposed.



9.19.2 Removing the display arm

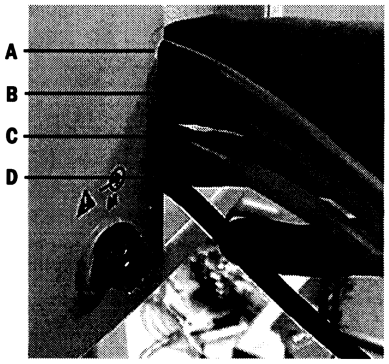
If equipped, remove additional equipment from the arm before removing the arm.

1. Disconnect the cables from the display.
2. Remove the display from the display arm.
3. Remove the cables from the cable clamps.
4. Loosen the screws that secure the display arm in the dovetail.
5. If required, use a rubber mallet to tap the display arm out of the dovetail.



9.19.3 Replacing a display cable

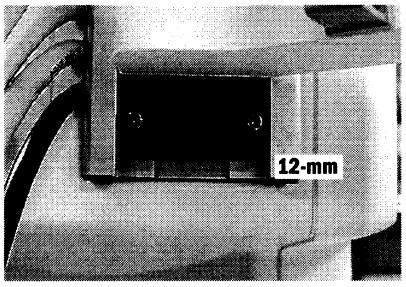
1. Remove the three screws that hold the dovetail extrusion to the upright. Remove the extrusion to allow cable replacement.
2. As require to access the particular cable routing for replacement, remove either (or all):
   - the rear cover (Section 9.2),
   - the tabletop (Section 9.3),
   - or the AC Inlet module.
3. After replacing the cable, place the cables in the notches in the order shown.
   - A - Serial Isolation
   - B - Monitoring
   - C - Vent Engine
   - D - Power cable
4. Install the dovetail extrusion loosely to hold the cables in place.
5. Adjust the cable length outside the machine to approximately:
   - 66 cm for the long arm or the short arm
   - 43 cm for the folding display mount (Aespire 100)
6. Securely tighten the extrusion mounting screws.

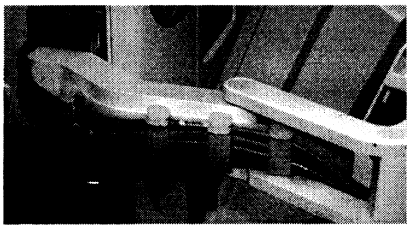


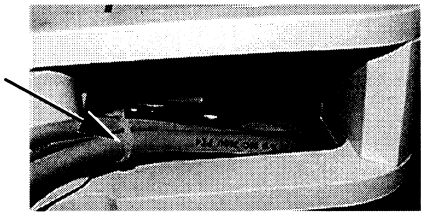
9.19.4 Installing the long arm

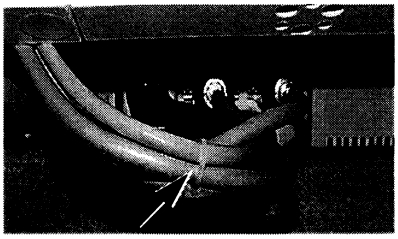
A current production long arm does not include integral cable clamps. Refer to Section 10.34 for applicable cable guide kit. Attach the cable guide to the arm per instructions in the kit.

1. Place the arm into the extrusion.
2. Use a rubber mallet to tap the arm into place. Leave a 12-mm gap between the lower edge of the arm mounting plate and the end of the dovetail.
3. Tighten the mounting screws to secure the display arm.
4. Remount the display.
5. Route the display cables neatly through the cable guide.
6. Attach the cables to the display.
7. If required, install cable tie in the locations shown.
   - Place one cable tie close to the pivot of the arm.
   - Place the second cable tie near the display as shown.
8. Ensure that the cables are secured so that they do not interfere with the display arm through the entire range of motion.



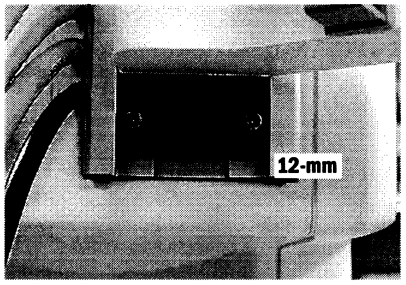


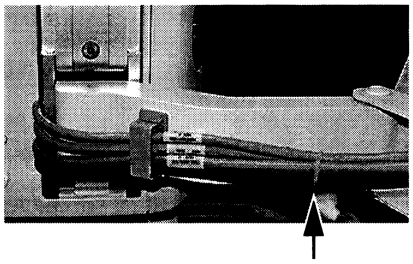


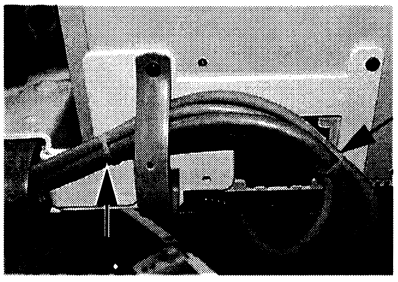


9.19.5 Installing the short arm

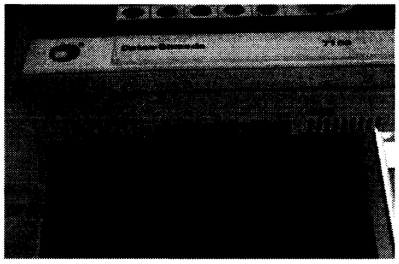
1. Place the arm into the extrusion.
2. Use a rubber mallet to tap the arm into place. Leave a 12-mm gap between the lower edge of the arm mounting plate and the end of the dovetail.
3. Tighten the mounting screws to secure the display arm.
4. Remount the display.
5. Route the display cables neatly through the cable clamps.
6. Attach the cables to the display.
7. If required, install cable tie in the locations shown.
   - Place one cable tie close to the pivot of the arm.
   - Place the second cable between the two straps.
   - Place the third cable tie near the display as shown.
8. Ensure that the cables are secured so that they do not interfere with display through the entire range of motion.



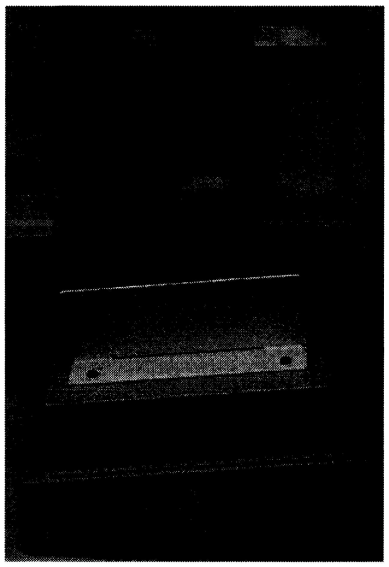




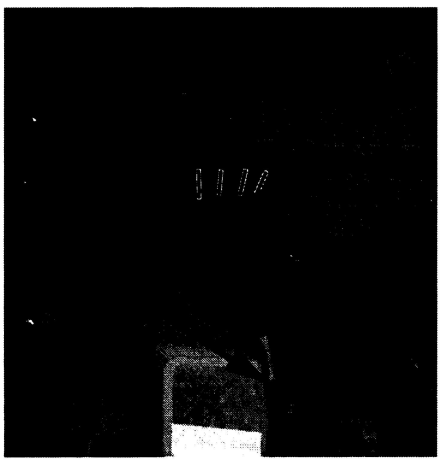
9.20 Replace display and cables in ProTIVA machine

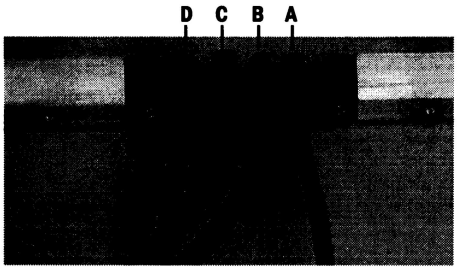


1. Remove two thumbscrews that secure the display mounting bracket to the no-vap manifold.
2. Lift the display slightly to disengage the mounting pins.
3. Lower the display face down on the worksurface.
4. Replace the display and reassemble in reverse order.



5. **To replace a cable**, remove the retaining block and feed the cable to the back of the machine.
6. As require to access the particular cable routing for replacement, remove either (or all):
   - the rear cover (Section 9.2),
   - the tabletop (Section 9.3),
   - or the AC Inlet module.
7. Attach the cable to the display.
8. When replacing the cable retainer, ensure:
   - that the cables fit properly in their feed-through slots (as detailed below),
   - and that they extend out of the machine with minimal slack.
9. From the back of the machine, ensure that the cables are routed such that they do not interfere with the replacement of the rear cover.





A - Serial Isolation

B - Monitoring board

C - Vent Engine

D - Power cable

9.21 Change drive gas

⚠ **CAUTION** If you change the drive gas, you must also change the drive gas selection on the ventilator service setup screen. Refer to Section 4 of the ventilator Technical Reference manual.

- If the drive gas selection and the actual drive gas do not agree, volumes will not be correct.

The ventilator will alarm with the message "Low Drive Gas Press" if the selected drive gas pressure, either O_2 or Air, is lost.

1. Remove the rear panel (Section 9.2).

Note: The O_2 and Air pipeline manifolds have a drive gas connection at the back. The connection not in use is plugged.

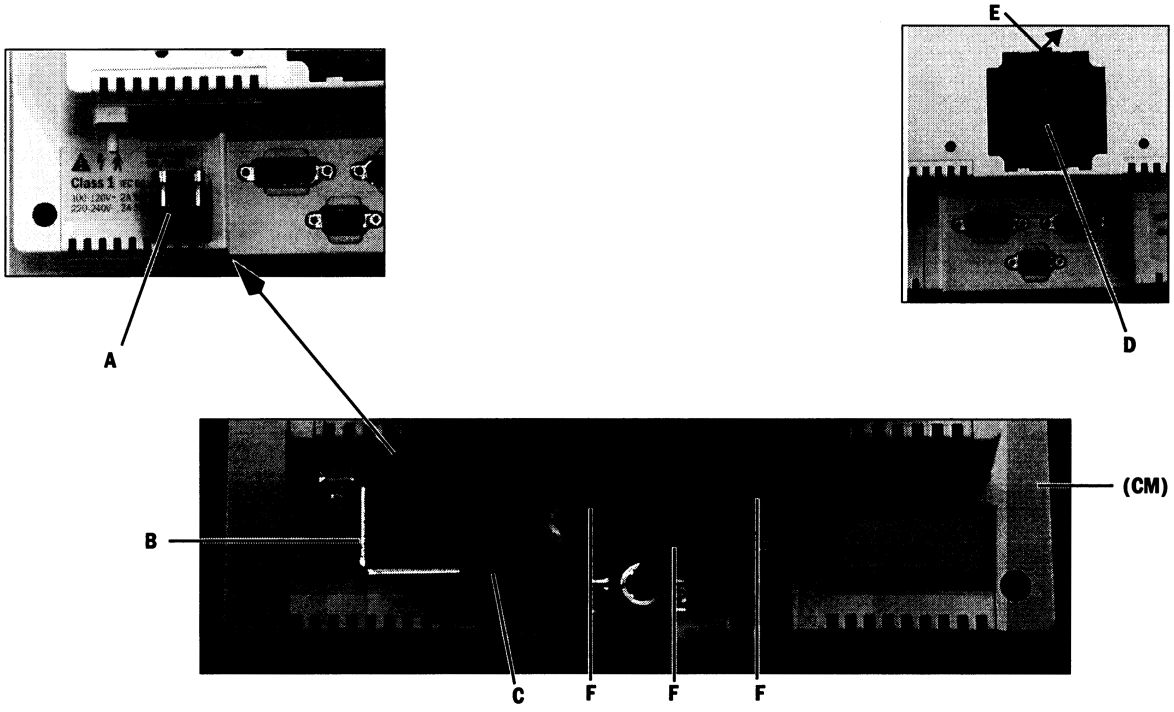
2. Remove the plug from the new connection.
3. Disconnect the drive gas hose from the present connection.
4. Install the plug in this connection (pull on the plug to ensure that it is locked into the fitting).
5. Reroute the drive gas hose so that it does not cause kinks in other tubing.
6. Connect the drive gas hose to the new connection (pull on the hose connector to ensure that it is locked into the fitting).
7. Do a high-pressure leak test (Section 3.3).
8. Enter the service mode and select the correct drive gas.
9. Test the primary regulator. Verify that it functions within specifications now that it will be supplying drive gas to the ventilator (Section 5.1).
10. Perform the checkout procedure (Section 3).

9.22 Control module

The control module is mounted on either a folding mount or on a display arm. In addition to the power cord, signals between the control module and the machine mounted components are sent through three cables that pass through the side of the machine and connect to the rear of the control module.

To service the color display, refer to Section 9.22.1.

To service the original display, refer to Section 9.22.2.



To replace the fuses and the fan filter

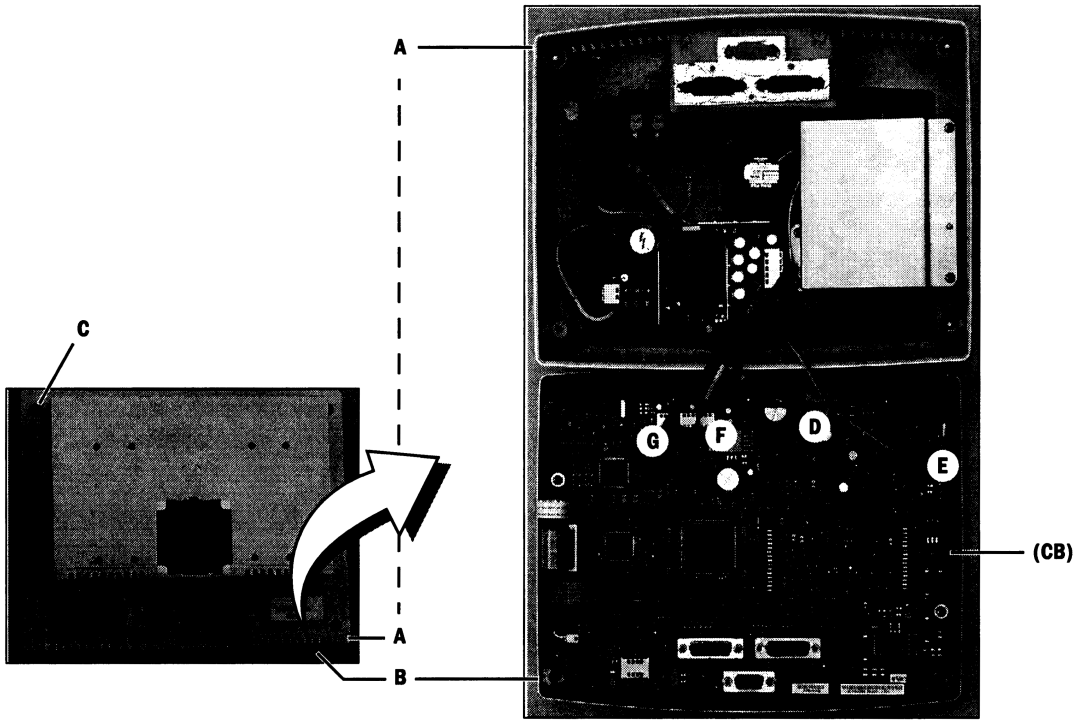
- To replace the fuses (**A**), first remove the power cord retainer (**B**) and the power cord (**C**).
- To replace the filter (**D**), remove the filter retainer (**E**). If the Control Module is mounted on an arm, remove the control panel from the arm to access the filter.

To remove the control module

1. Disconnect the three interface cables (**F**) and the power cord (**C**).
2. Remove the screws that attach the control module to the mounting brackets.
3. Remove the control module (**CM**).
4. To replace the control module, reassemble in reverse order.
5. Refer to Section 8.3 for installing software and updating the control board configuration.

9.22.1 Color control module

The control module consists of two enclosures: the rear enclosure (**A**) and the front enclosure (**B**). To access components within each enclosure, separate the two halves.

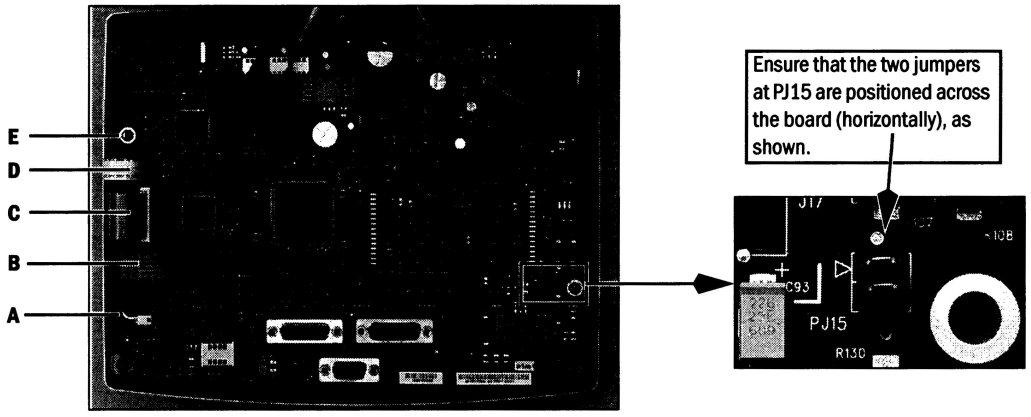


Opening the control module

1. Place the control module face down on a protected surface.
2. Loosen the screws (**C**) that hold the two enclosures together (one in each corner).
3. Slightly separate the rear enclosure (**A**) from the front enclosure (**B**).
4. Swing the rear enclosure into an upright position. Lift up the edge that houses the external connectors. Be careful not to stress the harnesses in the back.
5. Disconnect the harnesses from the back of control board (**CB**) to separate the two enclosures.
   - Battery (**D**)
   - Ground (**E**)
   - Power supply (**F**)
   - Fan (**G**)

⚠ Caution When disassembling, remove the battery connector first. When reassembling, attach the battery connector last. Power is supplied to the control board as long as the battery is plugged in.

Control board



⚠ Caution The circuit boards are electrostatic sensitive. Use an anti-static workstation and wear a wrist grounding strap when handling a circuit board.

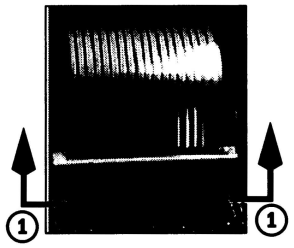
To replace the control board

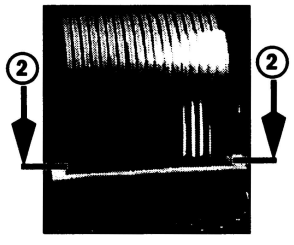
1. Disconnect the remaining cables at the left edge of the control board.
   - (**A**) Two-wire harness to speaker
   - (**B**) Ribbon cable to rotary encoder
   - (**C**) Flex cable to front panel keyboard (**refer to Note**)
   - (**D**) Flex cable to LCD display (**refer to Note**)
2. Remove the two screws (**E**) that hold the control board to the front enclosure.
3. Carefully lift the control board from the front enclosure. Guide the cables through the slotted openings at the left edge of the control board.
4. Reassemble in reverse order.
5. Refer to Section 8.3 for installing software and attaching the control board configuration label.

Note The flex cable for the LCD display and the front panel keyboard inserts into a ZIF (zero insertion force) connector on the control board.

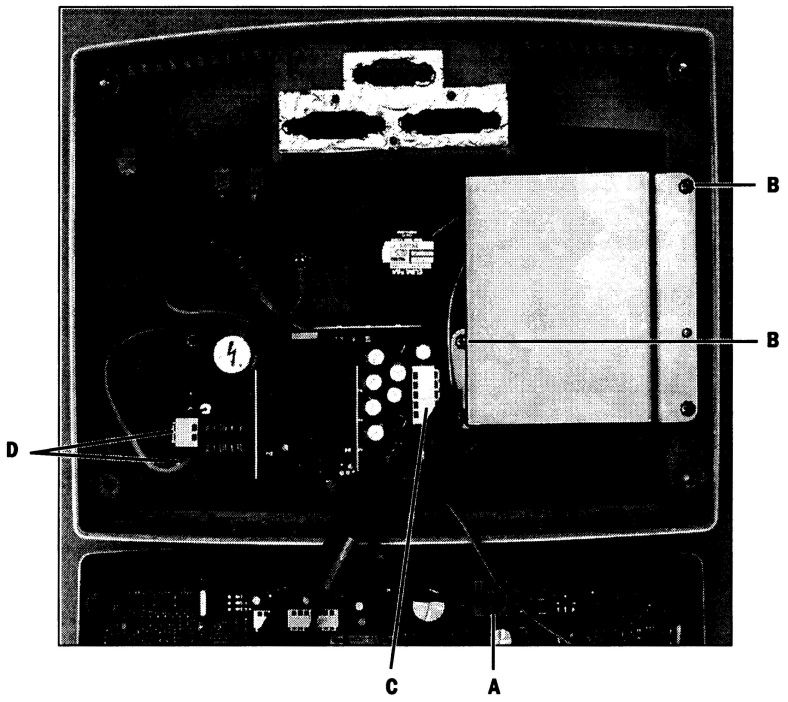
To release the flex cable (1), insert a thin slotted screwdriver at the base of the connector and twist it slightly to pry up on the outer shell of the connector.

To Insert the flex cable (2), hold the outer shell in the released position. Carefully insert the cable until all the "fingers" are below the surface of the shell. Push the shell to the locked position.





Battery and power supply



⚠ Caution The circuit boards are electrostatic sensitive. Use an anti-static workstation and wear a wrist grounding strap when handling a circuit board.

To replace the Battery

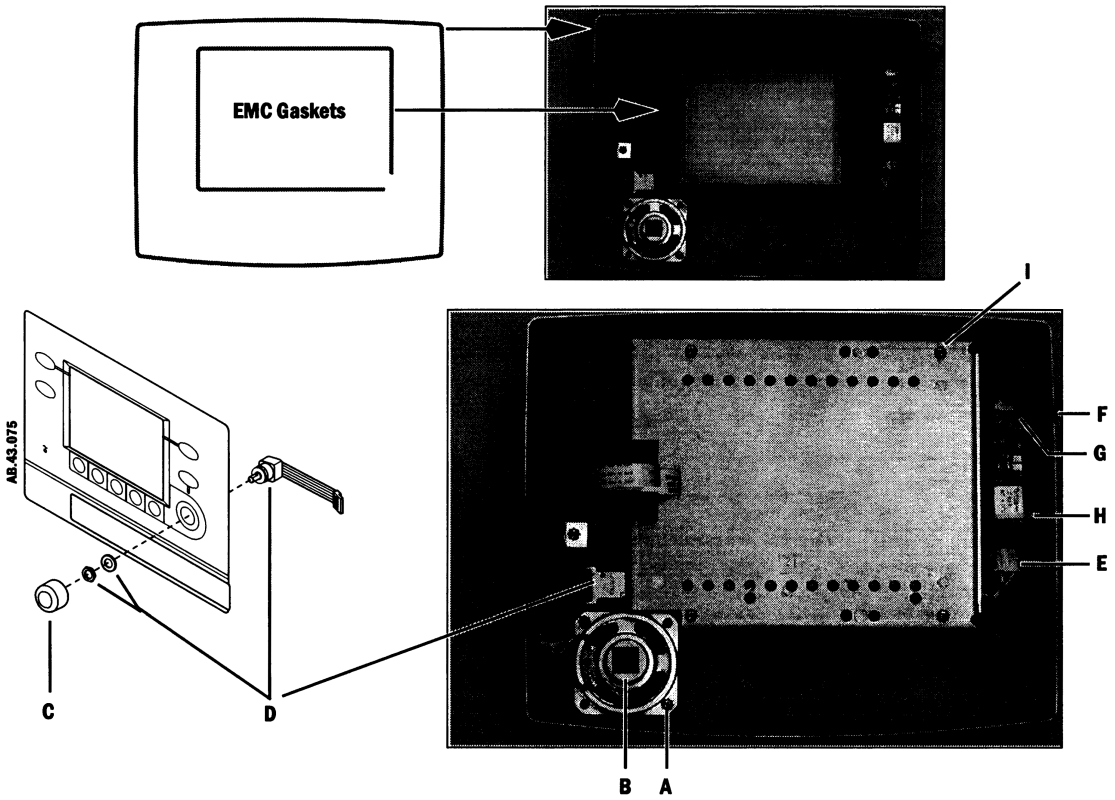
1. Disconnect the battery cable (**A**) from the control board.
2. Remove the four screws (**B**) that hold the battery retainer plate.
3. Note the orientation of the wires that connect to the battery and how they route through the retaining clamp.
4. Replace the battery in the same orientation noted above (wires facing inward.

Note: After replacement, the battery must be charged until Battery Status is indicated as "Battery Charged." Refer to Section 4.10.3.

To replace the Power Supply

1. Disconnect the battery cable (**A**) from the control board.
2. Disconnect the power supply's output connector (**C**).
3. Disconnect the power supply's input connector and ground wire (**D**).
4. Loosen each mounting screw (four corners) until it begins to ratchet.
5. Lift out the power supply.
6. Reassemble in reverse order.

Front enclosure with control board removed



To replace the speaker

Remove the two screws (**A**) that hold the speaker assembly (**B**) to the front enclosure.

To replace the rotary encoder

1. Pull the knob (**C**) off the shaft of the encoder (**D**).
2. Remove the nut and washer that hold the encoder to the keyboard.
3. Replace the encoder switch in reverse order (note the orientation of the attached ribbon cable).

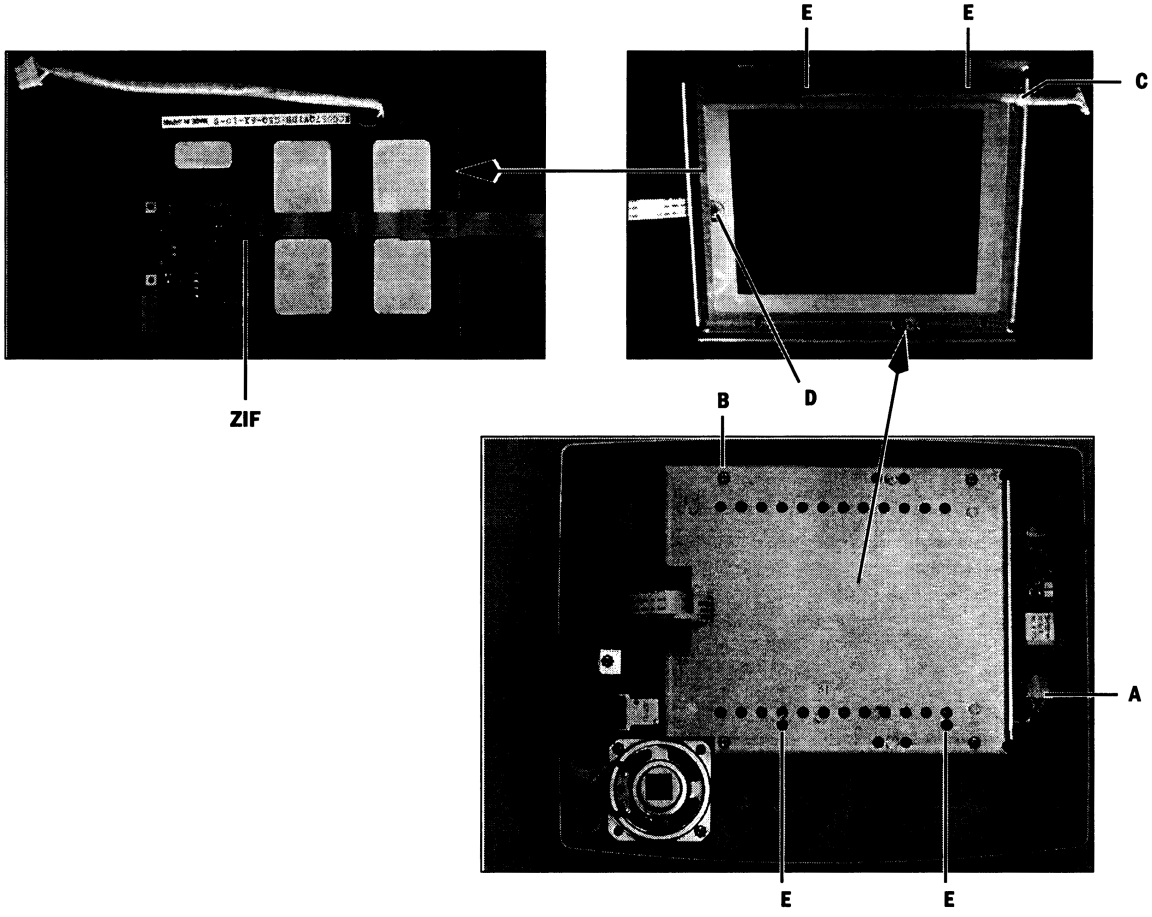
To replace the backlight inverter

1. Disconnect the LCD backlight cable (**E**) and the inverter input cable (**F**).
2. Remove the two screws (**G**) that hold the inverter board to the front enclosure.
3. Clip the tie wrap (**H**) to release the inverter.
4. To replace the backlight inverter, reassemble in reverse order.
   - Insert the tie wrap provided with the inverter into the holder before mounting the inverter.

To replace the front enclosure

1. Remove the four screws (**I**) that hold the LCD assembly to the front enclosure. Set the assembly aside.
2. Transfer the EMC gaskets (or install new) to the new enclosure.
3. Attach the LCD assembly to the new enclosure.
4. Transfer the remaining components to the new enclosure (speaker, encoder, inverter).
5. Reassemble in reverse order.

To replace the color LCD display

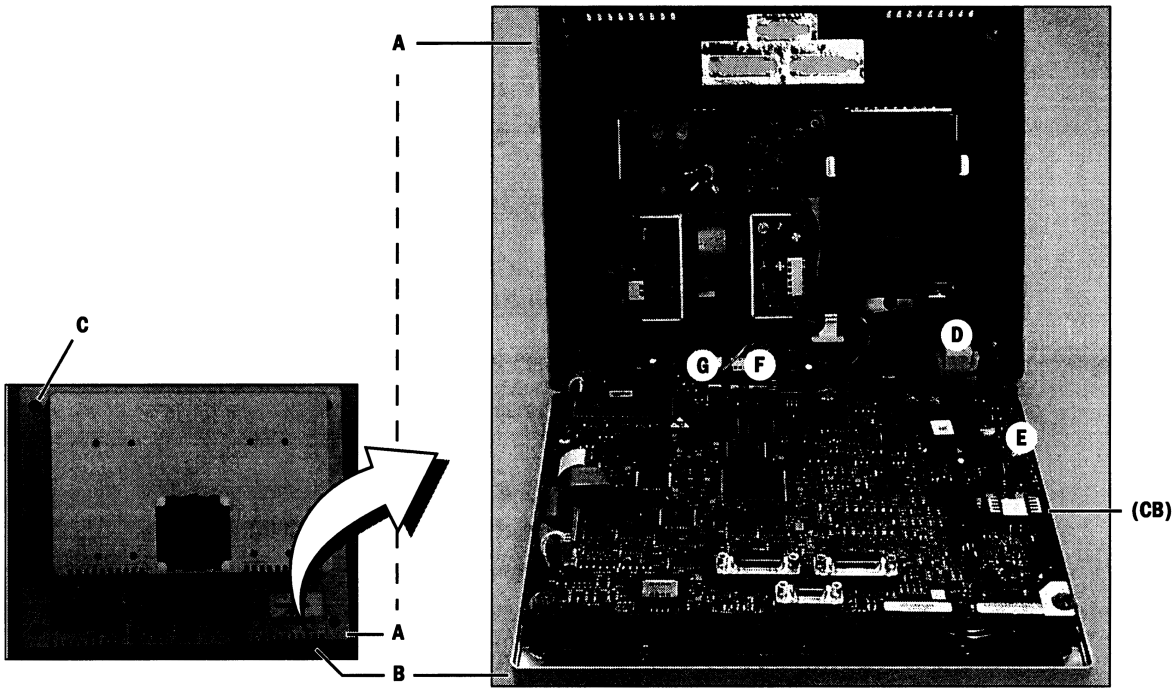


To replace the LCD display

1. Disconnect the LCD backlight cable (**A**).
2. Remove the four screws (**B**) at each corner of the display mounting bracket.
3. Remove the display assembly from the front enclosure.
4. Clip the tie wrap (**C**) to release the backlight cable.
5. Remove the screw (**D**) that holds the LCD display to the mounting bracket.
6. Remove the LCD display from the mounting bracket.
7. Transfer the display flat-flex cable (**contacts facing up**) to the new display (**ZIF** connector; pull tabs toward cable to release).
8. Remove protective mask from new LCD display.
9. If required, clean the enclosure window (if new, remove protective film).
10. Reassemble in reverse order.
    - To ensure that the backlight cable is not pinched under the mounting bracket, verily that the cable is visible through the two holes (**E**) in the bracket.

9.22.2 Original control module

The control module consists of two enclosures: the rear enclosure (**A**) and the front enclosure (**B**). To access components within each enclosure, separate the two halves.

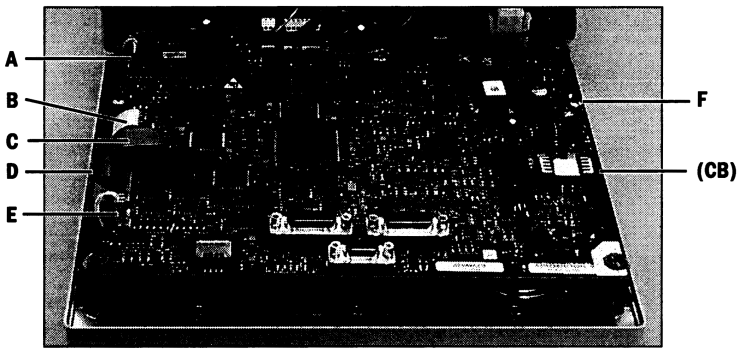


Opening the control module

1. Place the control module face down on a protected surface.
2. Loosen the screws (**C**) that hold the two enclosures together (one in each corner).
3. Slightly separate the rear enclosure (**A**) from the front enclosure (**B**).
4. Swing the rear enclosure into an upright position. Lift up the edge that houses the external connectors. Be careful not to stress the harnesses in the back.
5. Disconnect the harnesses from the back of control board (**CB**) to separate the two enclosures.
   - Battery (**D**)
   - Ground (**E**)
   - Power supply (**F**)
   - Fan (**G**)

⚠ Caution When disassembling, remove the battery connector first. When reassembling, attach the battery connector last. Power is supplied to the control board as long as the battery is plugged in.

Control board



⚠ Caution The circuit boards are electrostatic sensitive. Use an anti-static workstation and wear a wrist grounding strap when handling a circuit board.

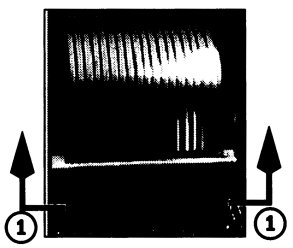
To replace the control board

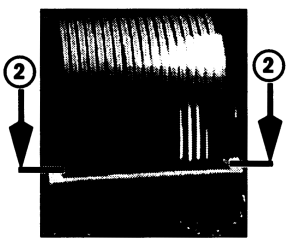
1. Disconnect the remaining cables at the left edge of the control board (**CB**).
   - (**A**) Two-wire harness to display backlight
   - (**B**) Flex cable to LCD display
   - (**C**) Ribbon cable to rotary encoder
   - (**D**) Flex cable to front panel keyboard (**refer to Note**)
   - (**E**) Two-wire harness to speaker
2. Remove the two screws (**F**) that hold the control board to the front enclosure.
3. Carefully lift the control board from the front enclosure. Guide the cables through the slotted openings at the left edge of the control board.
4. Reassemble in reverse order.
5. Refer to Section 8.3 for installing software and attaching the control board configuration label.

Note The Flex cable for the front panel keyboard inserts into a ZIF (zero insertion force) connector on the control board.

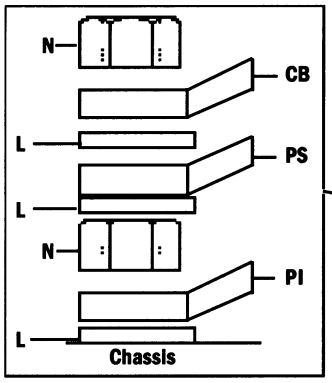
To release the flex cable (1), insert a thin slotted screwdriver at the base of the connector and twist it slightly to pry up on the outer shell of the connector.

To insert the flex cable (2), hold the outer shell in the released position. Carefully insert the cable until all the "fingers" are below the surface of the shell. Push the shell to the locked position.





Battery and power supply



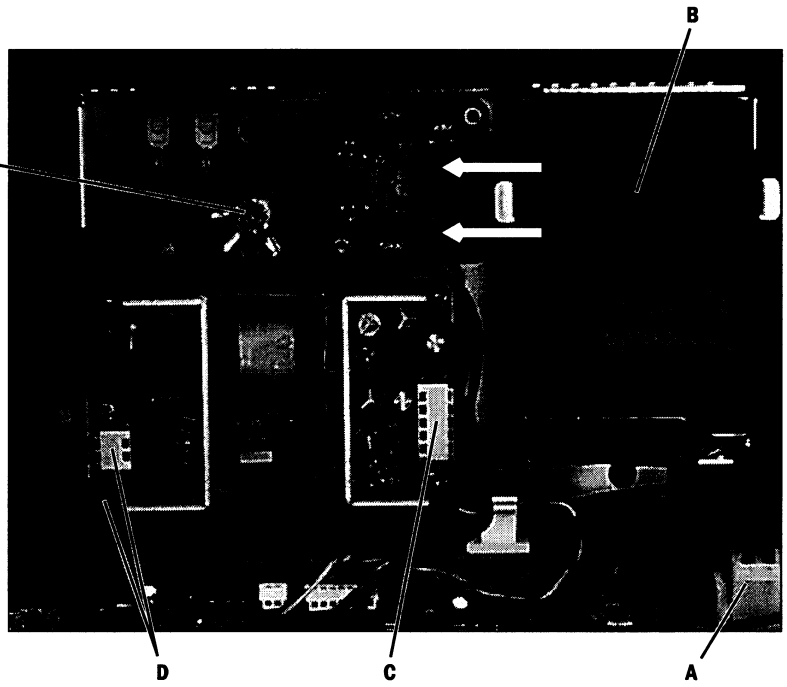
PI - Ground lug from Power Inlet

PS - Ground lug from Power Supply

CB - Ground lug from Control Board

L - Lockwasher

N - Keps nut



⚠ Caution The circuit boards are electrostatic sensitive. Use an anti-static workstation and wear a wrist grounding strap when handling a circuit board.

To replace the Battery

Note: After replacement, the battery must be charged until Battery Status is indicated as "Battery Charged." Refer to Section 4.10.3.

1. Disconnect the battery cable (**A**) from the control board.
2. Note the orientation of the wires that connect to the battery and how they route through the retaining clamp.
3. Remove the battery's mounting strap (**B**)
4. Replace the battery in the same orientation noted above (wires facing inward.

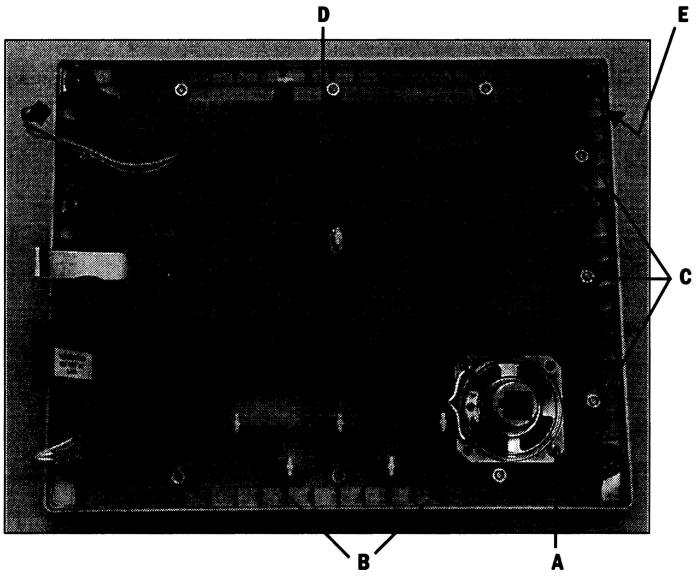
To replace the Power Supply

1. Disconnect the battery cable (**A**) from the control board.
2. Disconnect the power supply's output connector (**C**).
3. Disconnect the power supply's input connector and ground wire (**D**).
4. Loosen each mounting screw (four corners) until it begins to ratchet.
5. Lift out the power supply.
6. Reassemble in reverse order.

Ground Terminal

Note the sequencing of ground wires and hardware when replacing any of the harnesses.

Front enclosure with control board removed



To replace the speaker

1. Remove the two screws (**A**) that hold the speaker assembly (**B**) to the front enclosure.
2. Reassemble in reverse order.

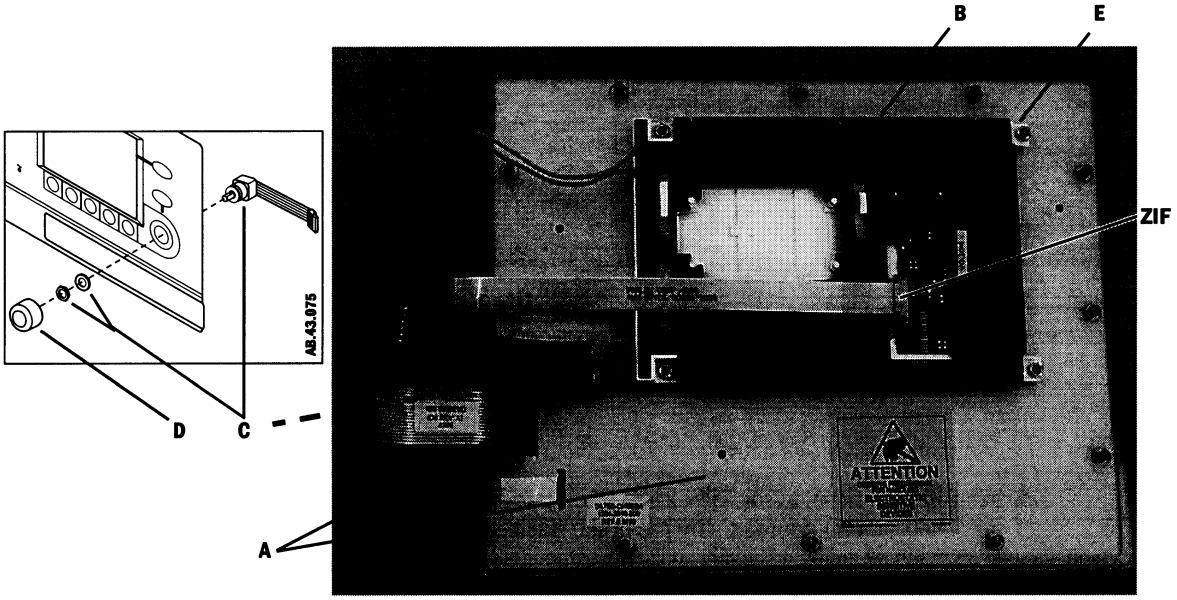
To remove the front enclosure

1. Use a 7-mm nut driver to remove the twelve nuts (**C**) around the periphery that hold the front enclosure (**D**) and the front panel assembly (**E**) together.
2. Carefully lift the front enclosure from the front panel assembly. Guide the cables through the slotted openings at the left edge of the front enclosure.
3. Reassemble in reverse order.

Front enclosure components

The front enclosure components include:

- The keyboard assembly (**A**)
- The LCD display assembly (**B**)
- The rotary encoder switch (**C**)



To replace the keyboard

The LCD display and the rotary encoder are mounted to the keyboard assembly. To replace the keyboard assembly you must transfer the LCD display and the rotary encoder to the new keyboard assembly.

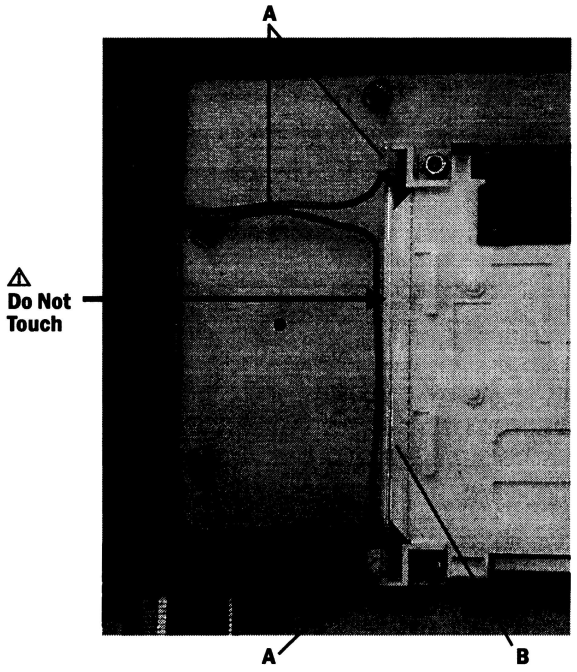
To replace the rotary encoder

1. Pull the knob (**D**) off the shaft of the encoder.
2. Remove the nut and washer that hold the encoder to the keyboard.
3. Replace the encoder switch in reverse order. Note the orientation of the attached ribbon cable.

To replace the LCD display

1. Use a 5.5-mm nut driver to remove the four nuts (**E**) at each corner of the display.
2. Remove the display assembly from the keyboard.
3. If required, clean the keyboard window (if new, remove protective film).
4. Remove protective mask from new LCD display.
5. Transfer the spacers over the display mounting studs.
6. Mount the display to the keyboard studs.
7. Transfer the display ribbon cable (**contacts facing up**) to the new display (**ZIF** connector; pull tabs toward cable to release).

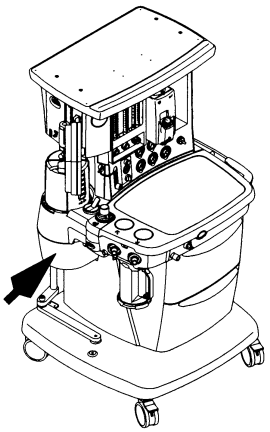
To replace the backlight



⚠ Caution Do not touch the glass portion of the backlight. Body oils or other contaminants can decrease the life of the backlight.

1. Remove the ribbon cable from the LCD display.
2. Remove the cover from the LCD display.
3. Carefully remove the backlight (**A**) from display assembly.
4. Guide the new backlight under the shielding flap (**B**) into the backlight cavity.
5. Replace the cover.
6. Replace the ribbon cable

9.23 Servicing the Vent Engine

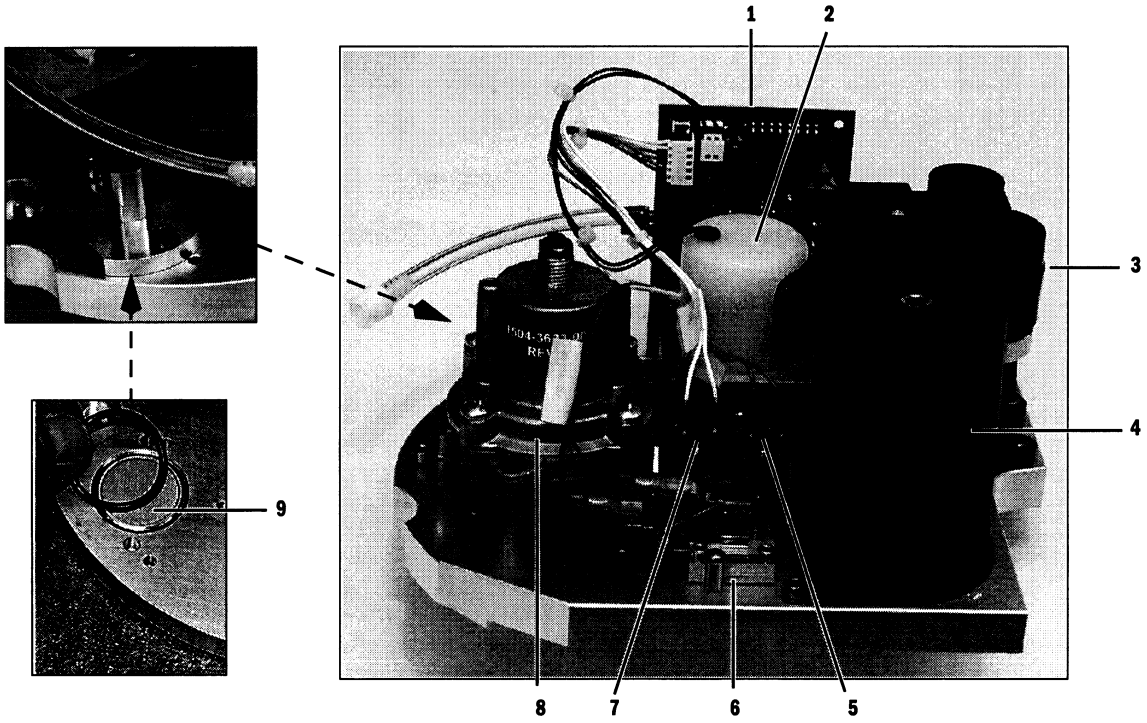


The Vent Engine is found in a housing located below the breathing system bellows assembly.

The Vent Engine includes the following subassemblies.

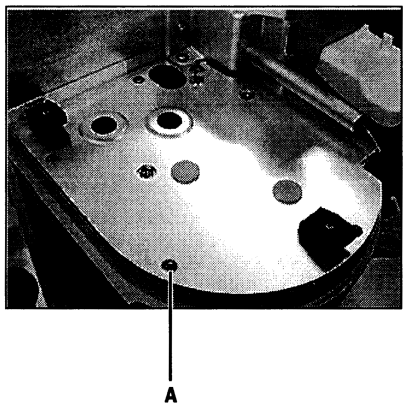
- Vent Engine Connector board (**1**)
- Flow Control Valve (**2**)
- Interface Manifold (**3**)
- Reservoir (**4**)
- PEEP Valve (**5**)
- Supply Pressure Switch (**6**)
- PEEP Safety Valve(**7**)
- Drive Gas Regulator (**8**)
- Inlet Filter (**9**) - located under the gas inlet valve

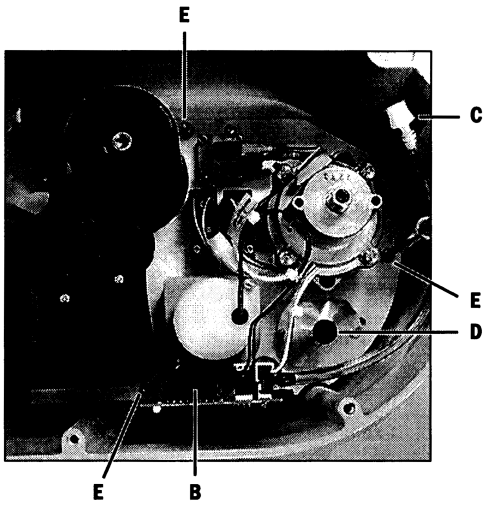
To replace any of the Vent Engine components, you must first remove the Vent Engine from the housing (refer to Section 9.23.1).



9.23.1 To remove the Vent Engine

1. Disconnect pipeline supplies; close cylinder valves; bleed off pressure.
2. Remove the ABS breathing system.
3. Remove the Exhalation valve.
4. If present, remove the scavenging downtube.
5. Loosen the five captive screws (**A**) that hold the Vent Engine cover to the housing. Raise the cover to access the Vent Engine.

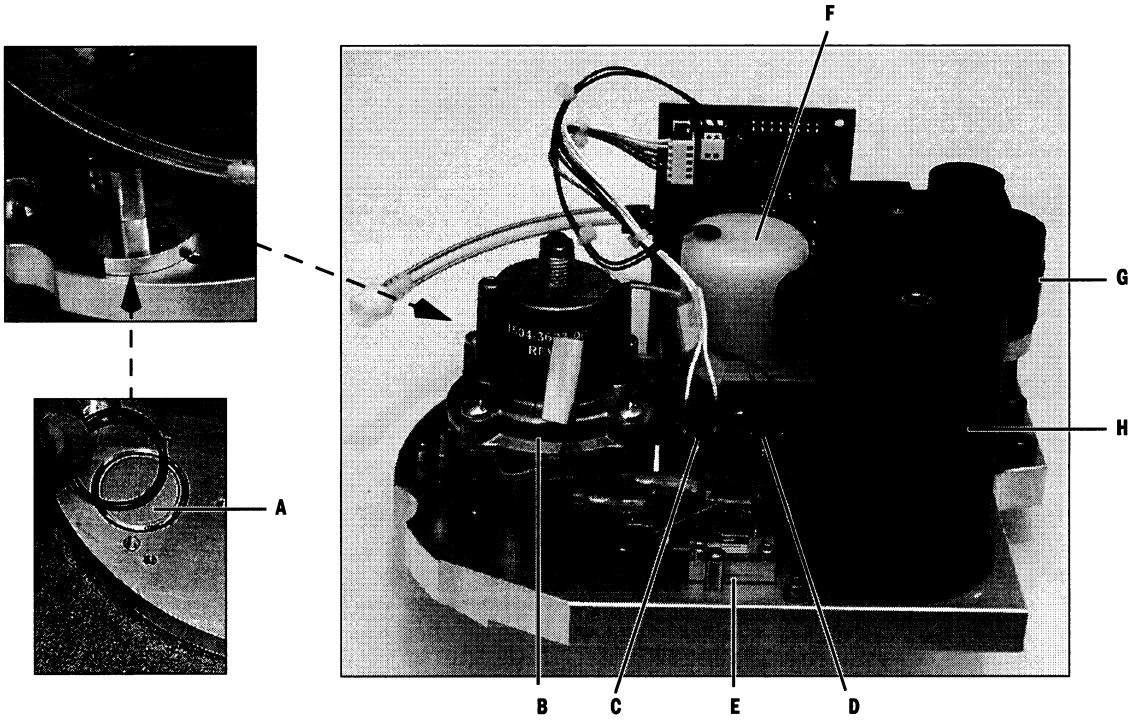




6. Disconnect the Vent Engine harness (**B**).
7. Disconnect the white tube-coupler (**C**) – inline with tube to pressure transducer on the Vent Engine Board.
8. If present, disconnect the black tube-coupler, inline with tube to scavenging.
9. Disconnect the drive gas hose (**D**).
10. Loosen the three captive screws (**E**) that hold the engine manifold to the housing.
11. Lift the Vent Engine out of the housing
12. To replace the Vent Engine, reassemble in reverse order.

9.23.2 Replacing Vent Engine components

Refer to section 6 for Vent Engine components that are to be serviced under regular maintenance. Most of the components on the Vent Engine can be replaced by removing the mounting screws and reusing them to secure the replacement part.



Inlet Filter (A) Install the filter (with the course side DOWN) into the recess in the manifold. Place the o-ring into its groove.

Regulator (B) Also inspect the two o-rings that seal it to the manifold. Replace as necessary.

PEEP Safety Valve (C) Ensure the valve you are installing (white dot) is in this location.

PEEP Valve (D) Ensure the valve you are installing (two blue dots) is in this location.

Supply Pressure Switch (E) Also inspect the o-ring that seal it to the manifold. Replace as necessary.

Transfer harness wire to top and middle tabs; bottom tab open.

Inspiratory Flow Valve (F) Note orientation of the flow valve. Also inspect the two o-rings that seal it to the manifold. Replace as necessary.

Reservoir (G) Inspect the two o-rings: reservoir to manifold, reservoir to screw head. Replace as necessary.

Interface Manifold (H) Inspect the two o-rings that seal it to the manifold. Replace as necessary. Lubricate o-rings sparingly with Krytox.

Notes

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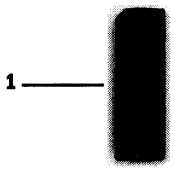
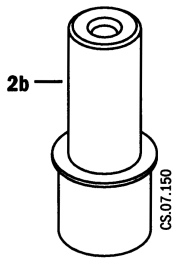
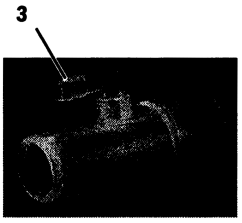
10.1 Service tools

Item	Tool		Stock Number	Reference
1	Software Memory Stick, (for non-color display)	SW Revision 1.3 SW Revision 1.4	1504-8130-000 1504-8150-000	Section 8.3 "Software Installation"
	Software Memory Stick, (for color and non-color display)	SW Revision 2.0	M1122167-S	Section 8.3 "Software Installation"
2	PEEP/INSP Calibrated Flow Orifice		1504-3016-000	Section 4.9.4 "Airway Sensor Span" (and others).
3	Airway Pressure Sensing Tee		1504-3011-000	Section 4.9.4 "Airway Sensor Span"

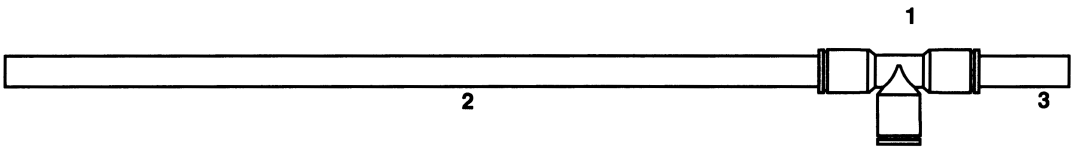






10.1.1 Secondary regulator pilot pressure tool

Assemble the secondary regulator pilot pressure tool using a 4-mm tee and tubing as shown. This tool is used with N_2O needle valve calibration.



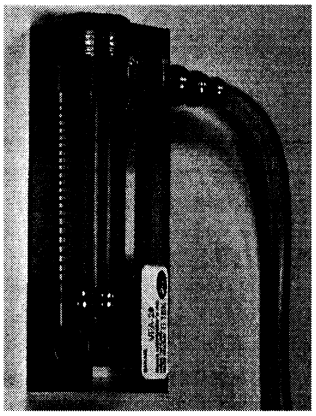
Item	Description	Stock Number
1	Tee, 4 mm, tube/tube/tube	1202-3653-000
2	Tubing, 4 mm (approximately 450 mm - 18 inches)	1001-3060-000
3	Tubing, 4 mm (approximately 50 mm - 2 inches)	1001-3060-000

10.1.2 Test Devices

Item	Tool		Stock Number
1	Test flowmeter, 6–50 L/min (Suction Flow Test)		1006-8431-000
Not Shown			
	Low-pressure Leak Test Device	(negative pressure)	0309-1319-800
	Low-pressure Leak Test Device	(positive pressure - ISO)	1001-8976-000
	Low-pressure Leak Test Device	(positive pressure - BSI)	1001-8975-000
	Flow test device capable of measuring 0–15 L/min with an accuracy of ±2% of reading		Refer to section 6.5
	Vacuum test gauge capable of measuring 0 to 550 mm Hg with an accuracy of ±1% of reading		Refer to section 6.6
	Test device capable of measuring 0–30 L/min (see Item 1 above)		Refer to section 6.6
	Leakage current test device		Refer to section 3.15
	Test device capable of measuring 689 kPa (100 psi)		Refer to section 5.1
	Low-pressure test device (digital manometer or test gauge) with an accuracy of ±2% of reading		Refer to section 5.6.2

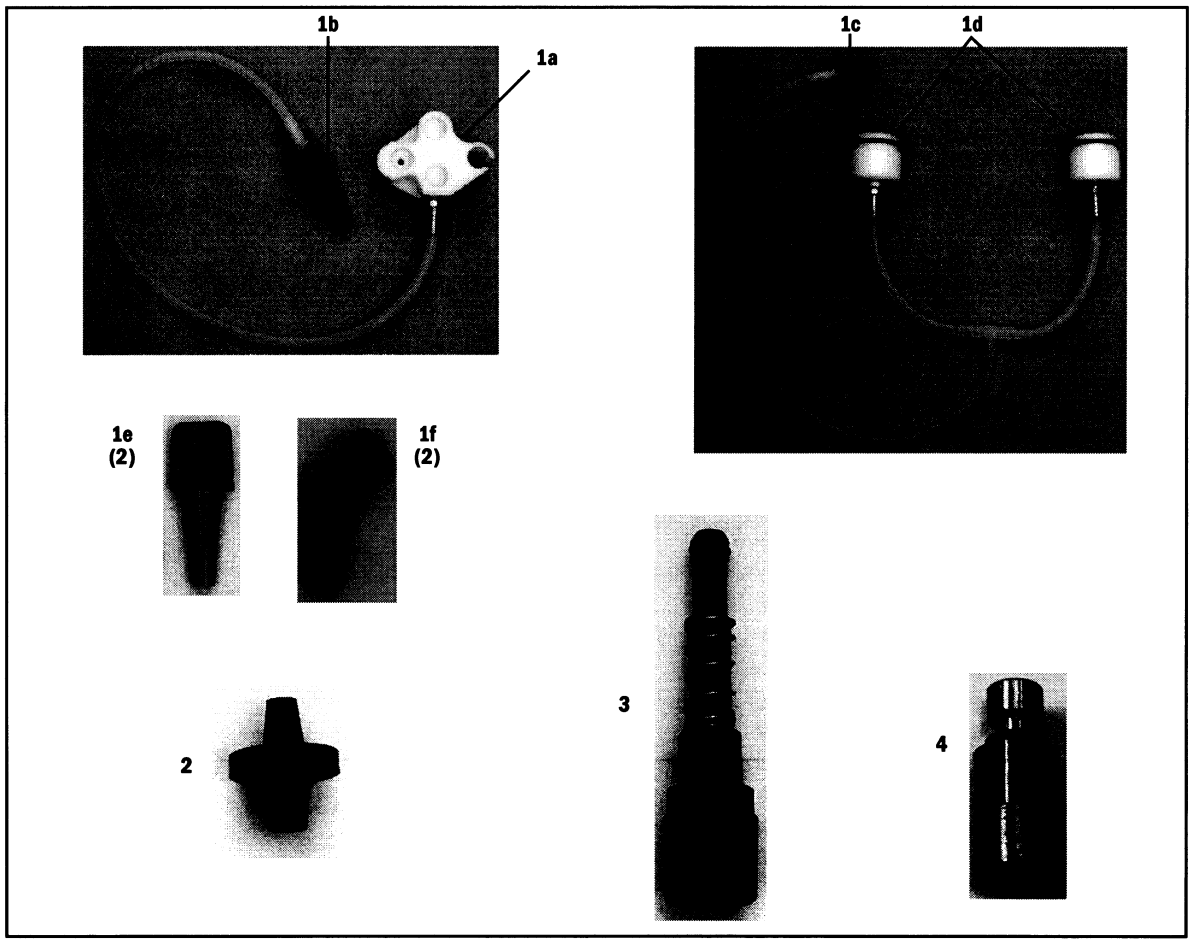
Test Devices

1

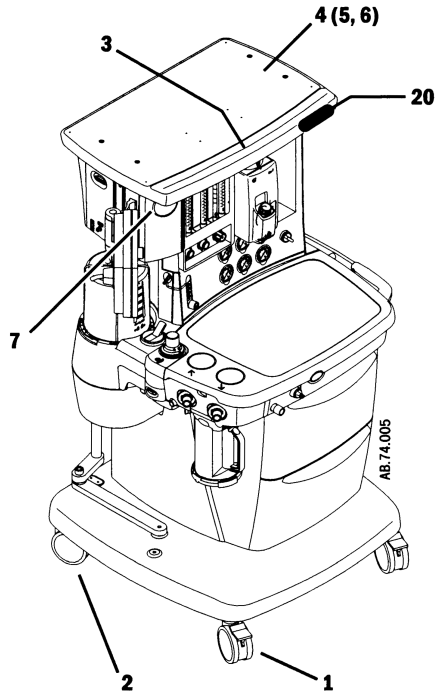


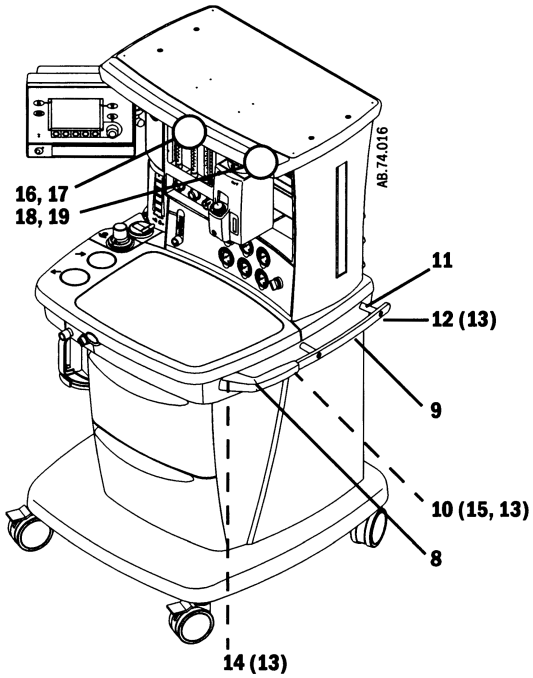
10.1.3 Test Tools

Item	Tool	Stock Number
1	Leak Test Tool Kit, ABS breathing system	1407-7013-000
1a	Test Tool, bulkhead	1407-8500-000
1b	Plug, tapered 27x12 mm	1407-8505-000
1c	Plug, tapered 24x18 mm	1407-8506-000
1d	Test Tool, circle module (2 each)	1407-8502-000
1e	Plug, service B/S 11 mm (2 each)	1407-8504-000
1f	Plug, service BTV 18 mm (2 each)	1407-8503-000
2	Plug, stopper	2900-0001-000
3	Adapter, positive low-pressure leak test	1009-3119-000
4	Vaporizer Manifold Valve Test Tool	1006-3967-000
Not Shown		
	Tool to help disconnect tubing from Legris fittings	2900-0000-000
	Test Lung	0219-7210-300
	Leak detection fluid, Snoop	obtain locally



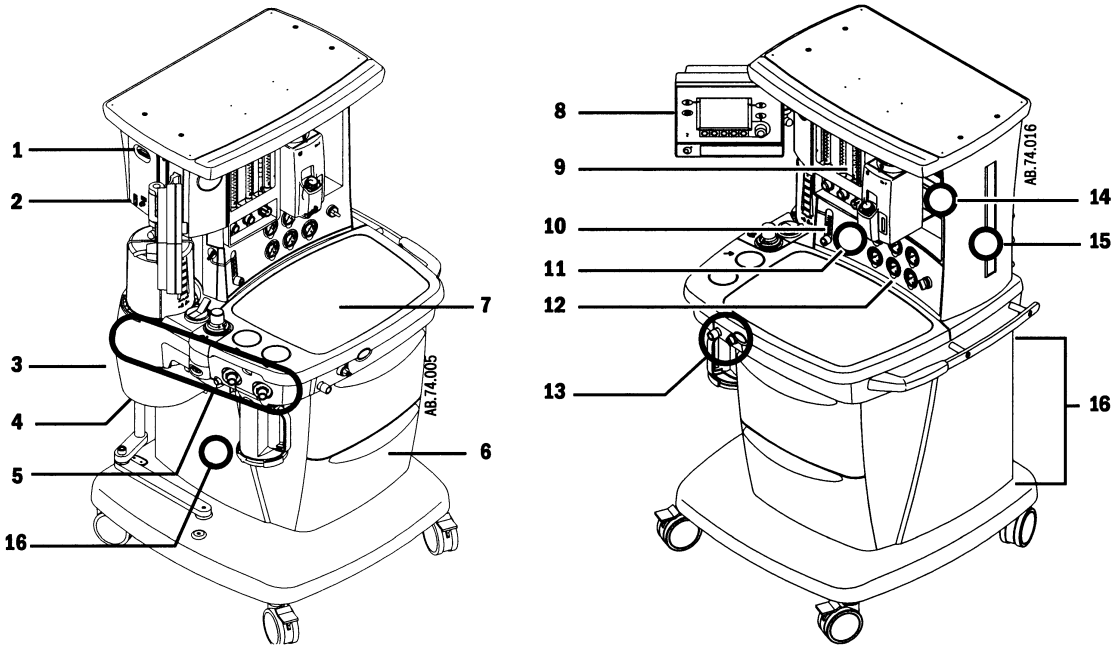
10.2 External components - front view





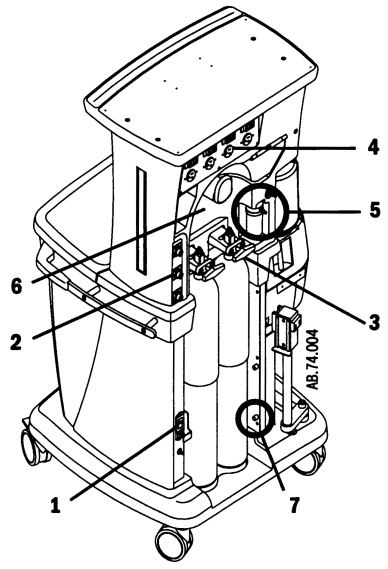
Item	Description	Stock Number
1	Caster, 125-mm with brake (front)	1006-3070-000
2	Caster, 125-mm no brake (rear)	1006-3071-000
3	Cover, cable channel	1009-3020-000
4	Upper shelf	1009-3022-000
5	Bolt, M6x40	0144-2131-911
6	Lockwasher, M6 internal	0144-1118-130
7	Gauge, airway pressure (includes mounting hardware)	1009-3034-000
8	Handle, side	1009-3033-000
9	Handle, Medirail	1009-3101-000
10	Screw, M6x12 Sems	0144-2436-106
11	Spacer	1009-3102-000
12	Screw. M6x70	0144-2131-923
13	Lockwasher M6 external	9213-0560-003
14	Screw, M6x20	0144-2131-921
15	Shim	1009-3131-000
16	Task Light PCB	1009-5504-000
17	Lens, Task Light	1011-3308-000
	Screw	0142-4254-106
18	Switch Assembly, task light	1009-5587-000
19	Plate, switch mounting retainer	1009-3143-000
	Screw	0140-6226-107
20	Label, Aespire	1009-3488-000

10.3 External components - front view references



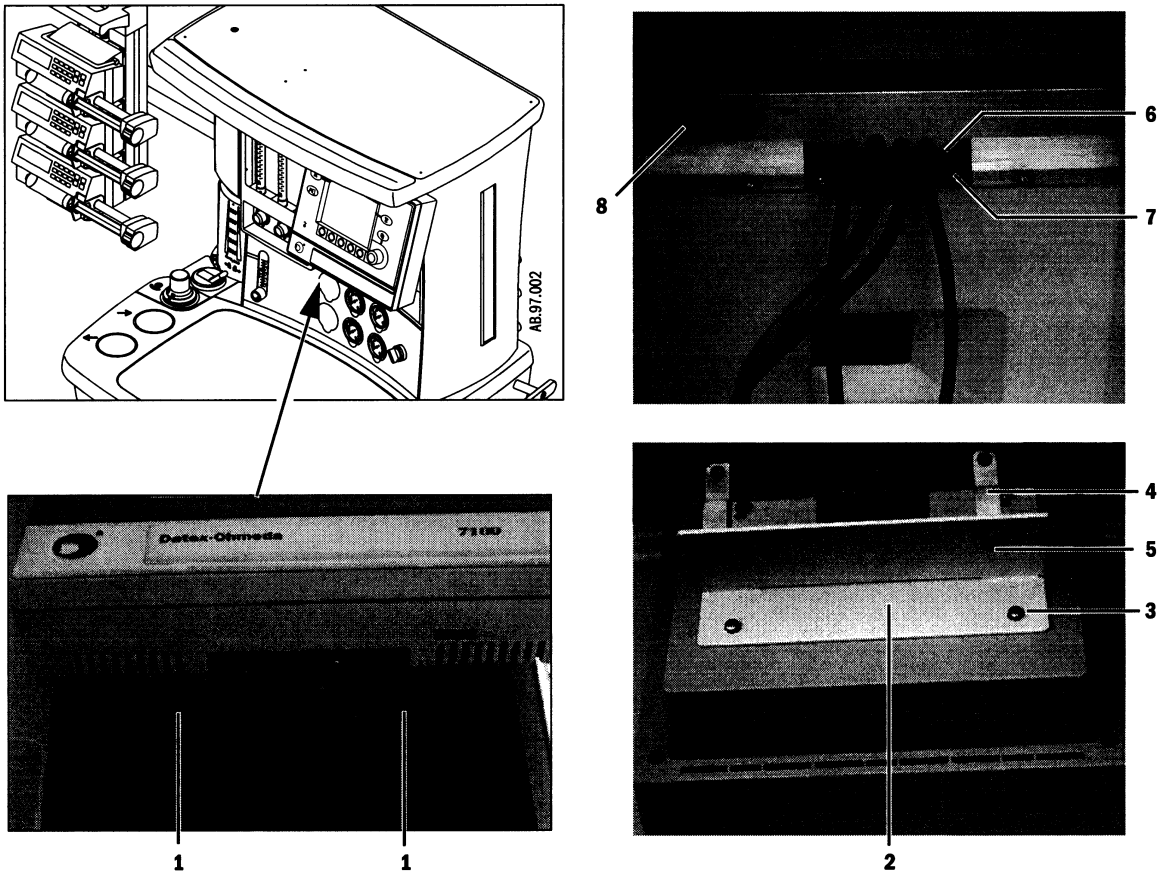
Item	Description	Section number
1	"Serial board"	Refer to section 10.22
2	"AGSS gauge, and sample return"	Refer to section 10.22
3	"Vent Engine Housing"	Refer to section 10.23
4	"Anesthetic Gas Scavenging System – AGSS"	Refer to section 10.31
5	"Breathing System"	Refer to section 10.21
6	"Drawer"	Refer to section 10.33
7	"Tabletop components"	Refer to section 10.9
8	"Display cables" "Display mounts"	Refer to section 10.22 Refer to section 10.34
9	"Flowmeter components"	Refer to section 10.17
10	"Auxiliary O_2 Flowmeter"	Refer to section 10.19
11	"Integrated Suction Regulator"	Refer to section 10.32
12	"Front panel, gauges and system switch"	Refer to section 10.7
13	"ABS to machine Interface Components"	Refer to section 10.18
14	"Vaporizer manifold"	Refer to section 10.16
15	"Right-side Components"	Refer to section 10.10
16	"External components - lower assembly"	Refer to section 10.11

10.4 External Components - rear view



Item	Description	Stock Number
1	AC Inlet	Refer to section 10.12
2	Pipeline Inlets Label, pipeline inlet blank	Refer to section 10.14 1009-3197-000
3	Cylinder Gas Supplies	Refer to section 10.15
4	Electrical Power Outlet Blank panel (no outlets) Screw, M4x12	Refer to section 10.13 1011-3329-000 1009-3109-000
5	Suction items	Refer to section 10.32
6	Rear panel items	Refer to section 10.8
7	Thumbscrew Ring, retainer	1406-3304-000 1406-3319-000

10.5 Control module mounting for a ProTIVA machine

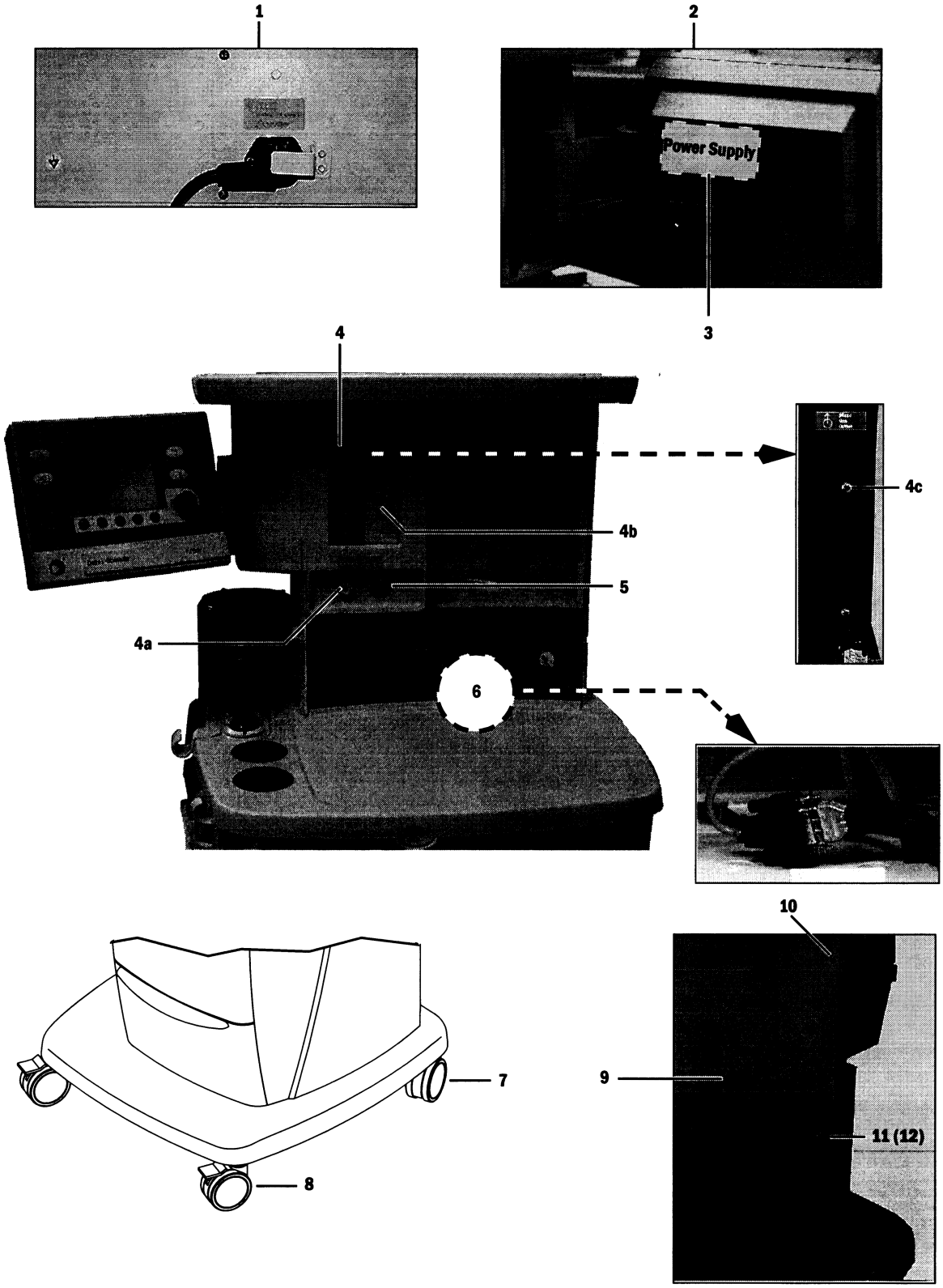


Item	Description	Stock Number
1	Thumbscrew, M6x14	1505-3005-000
2	Bracket, mount 7100 display TIVA	1009-3290-000
3	Screw, M4x12 Pozidriv Lockwasher, M4 external	0140-6226-111 9213-0540-003
4	Block, mount 7100 display TIVA	1009-3294-000
5*	Screw, M4x8 Pozidriv Flat HD	0140-6226-107
6	Clamp, cable TIVA	1009-3291-000
7	Screw, M6x14 SKT HD CAP	0144-2131-922
8	Manifold, display mount TIVA	1009-8232-000

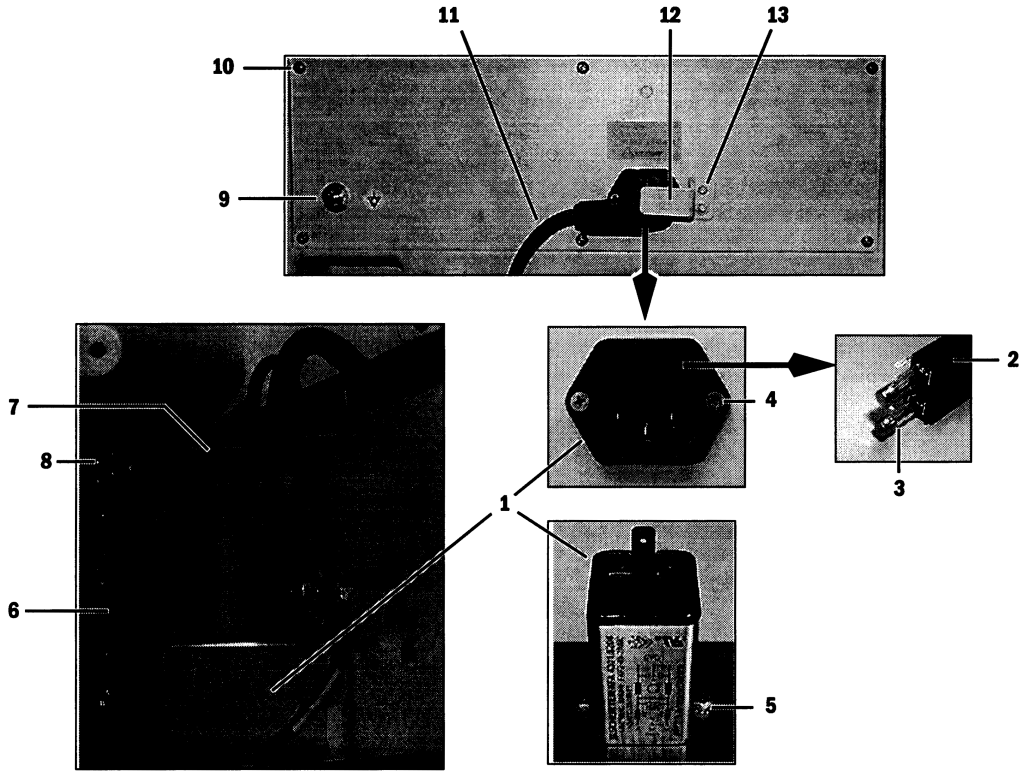
* Apply Loctite 242.

10.6 Aespire 100 - exclusive components

Item	Description	Stock Number
1	AC Inlet	Refer to section 10.6.1
2	Display mount components	Refer to section 10.6.2
3	Power supply, 40W universal (this supply is now used as a standard replacement for all 7100 display control modules)	1609-3040-000
4	Flowhead components (with the following exceptions, all components of the O_2 only flowhead are covered in the "Flowmeter components" section.	Refer to section 10.17
	4a Knob, O_2 (does not include label)	1006-3634-000
	4b Plate, flowtube blank	1006-1506-000
	4c Screw, tread forming 0.88 inch (this screw is slightly longer to compensate for the flowtube blank plate)	1009-3410-000
5	Blank Label Set (when replacing the flowmeter bezel, use appropriate label to cover unused flow control positions)	1009-3409-000
6	Harnesses	Refer to section 10.30
7	Caster, non-locking 4-inch	1009-3038-000
8	Caster, locking 4-inch	1009-3039-000
9	Panel, lower rear cover	1009-3407-000
10	Screw, M4x8	1006-3178-000
11	Thumbscrew	1406-3304-000
12	Ring, retaining	1406-3319-000

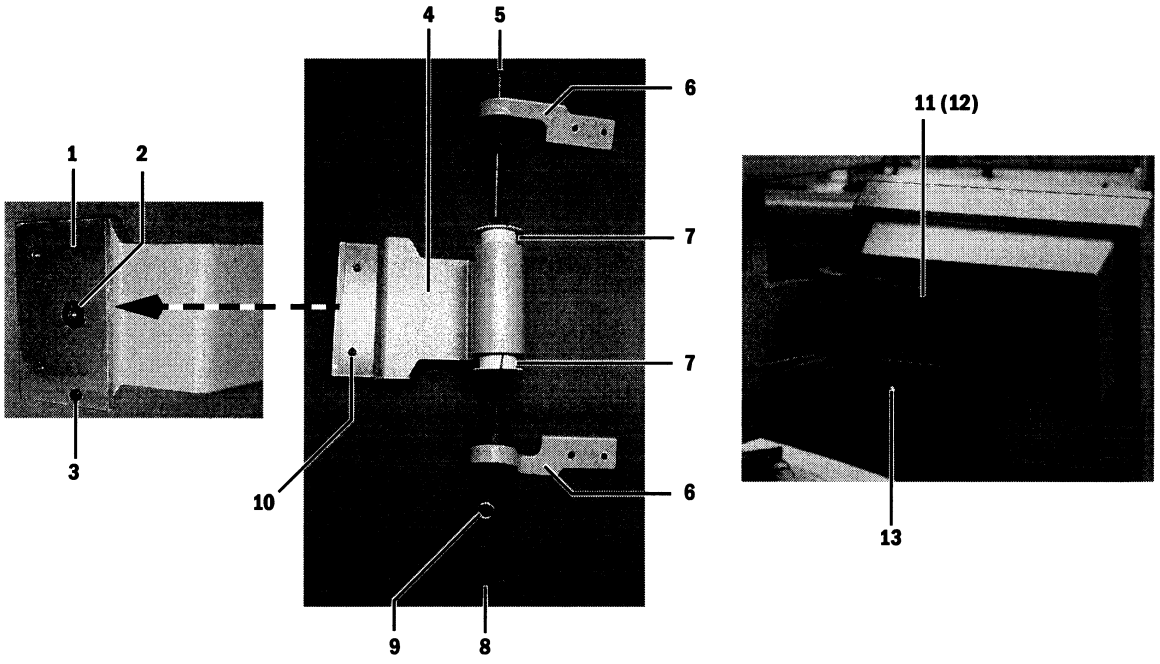

1
2
Power Supply
3
4
4b
5
4a
6
4c
7
8
10
9
11 (12)

10.6.1 AC Inlet (Aespire 100)



Item	Description	Stock Number
1	AC Inlet, with line filter	1609-3019-000
2	Fuse drawer	1609-3020-000
3	Fuse, 2A	1009-5778-000
4	Screw, M3x8	9211-0530-083
5	Nut, M3 Keps	0144-3717-302
6	Transient Suppression board	1609-3101-000
7	Standoff, 52-mm Long	1609-3320-000
8	Screw, M4x8	0140-6226-113
9	Stud, Equal Potential, 6-mm	0208-0070-300
10	Screw, M4x12	1009-3109-000
11	Power Cord	Refer to section 10.12
12	Clamp, power cord retainer (all except China) Clamp, power cord retainer (China)	1009-3405-000 M1057453
13	Screw, M4x8	1006-3178-000

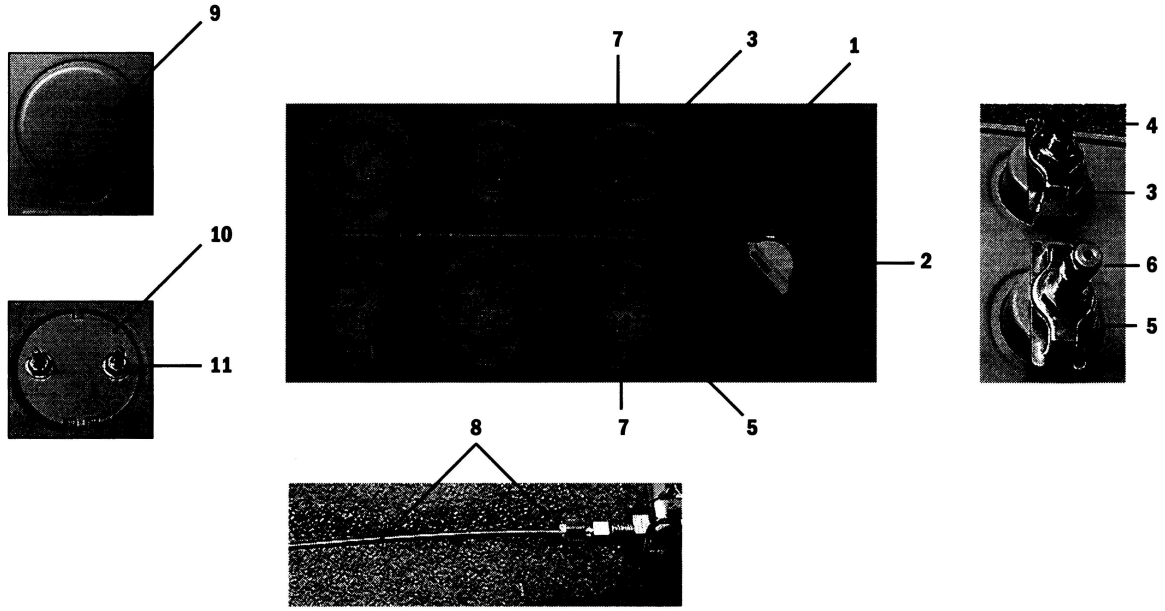
10.6.2 Display mount (Aespire 100)



Item	Description	Stock Number
1	Dovetail insert	1009-3408-000
2*	Screw, M8x16 FL SKT HD	1009-3435-000
3*	Screw, M8x12 SKT HD DOG PT	1006-1435-000
4	Extrusion, Vent bracket mount	1504-3514-000
5	Bolt, carriage	1006-1433-000
6	Casting, Vent Bracket, 20 degree (2)	1504-3526-000
7	Bearing, white plastic (2)	1006-3228-000
8	Handle, T-clamping	1301-3001-000
9	Washer, flat	9213-0180-006
10	Set screw, M6x16 SKT HD CUP	1009-3436-000
11	Screw, M4x16	9211-0440-163
12	Lockwasher, M4	0144-1118-128
13	Clamp	1504-3527-000

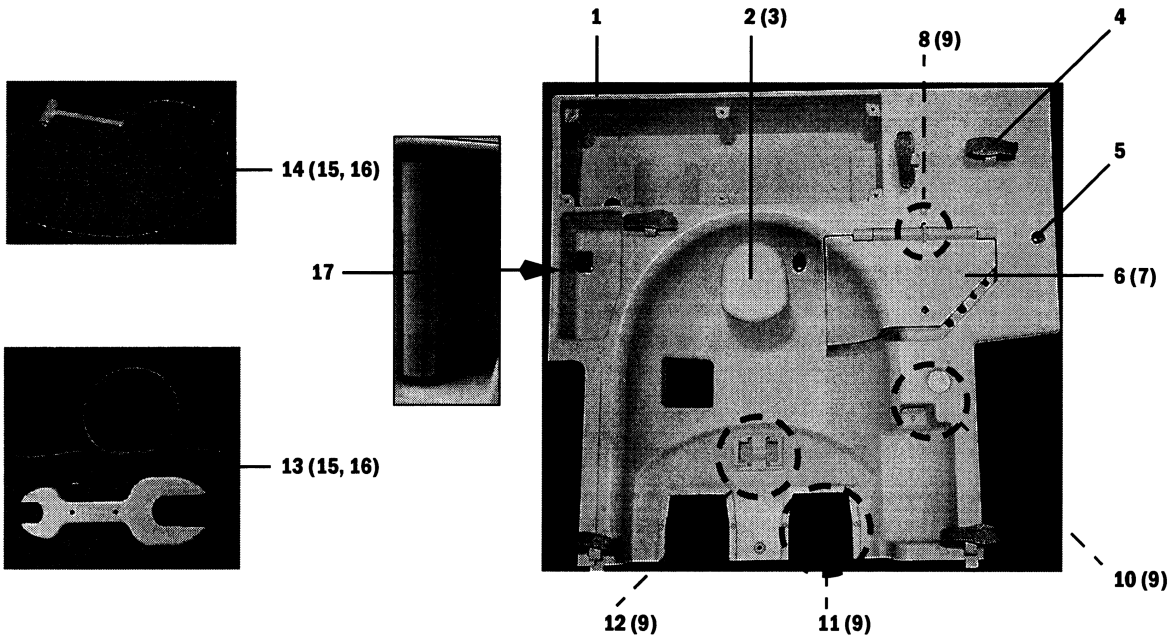
* Apply Loctite 242

10.7 Front panel, gauges and system switch



Item	Description	Stock Number	Stock Number (pipeline)	Stock Number (cylinder)
1	Panel, gauge front	1009-3018-000		
2	Switch, D-O system	1006-8452-000		
3	Gauge, low pressure (includes mounting hardware)		1009-3079-000	
4	Connector, 1/8 inch Legris to 10-32		1006-3711-000	
5	Gauge, high pressure (includes mounting hardware)			1009-3080-000
6	Connector, 1/8 inch copper tube to 5/16-24			1006-3712-000
7	Label, gauge	O_2 ANSI	1009-3081-000	1009-3199-000
		N_2O ANSI	1009-3082-000	1009-3201-000
		Air ANSI	1009-3083-000	1009-3200-000
		O_2 ISO	1009-3202-000	1009-3204-000
		N_2O ISO	1009-3082-000	1009-3201-000
		Air ISO	1009-3203-000	1009-3205-000
		O_2 Neutral	1009-3234-000	1009-3237-000
		N_2O Neutral	1009-3235-000	1009-3238-000
		Air Neutral	1009-3236-000	1009-3239-000
8	Tube Kit, copper tube and fittings (inboard cylinder)	1006-8371-000		
	Tube Kit, copper tube and fittings (3rd gas)	1006-8372-000		
9	Plate, gauge blanking	1009-3045-000		
10	Plate, gauge blank backing	1009-3147-000		
11	Palnut	1009-3090-000		

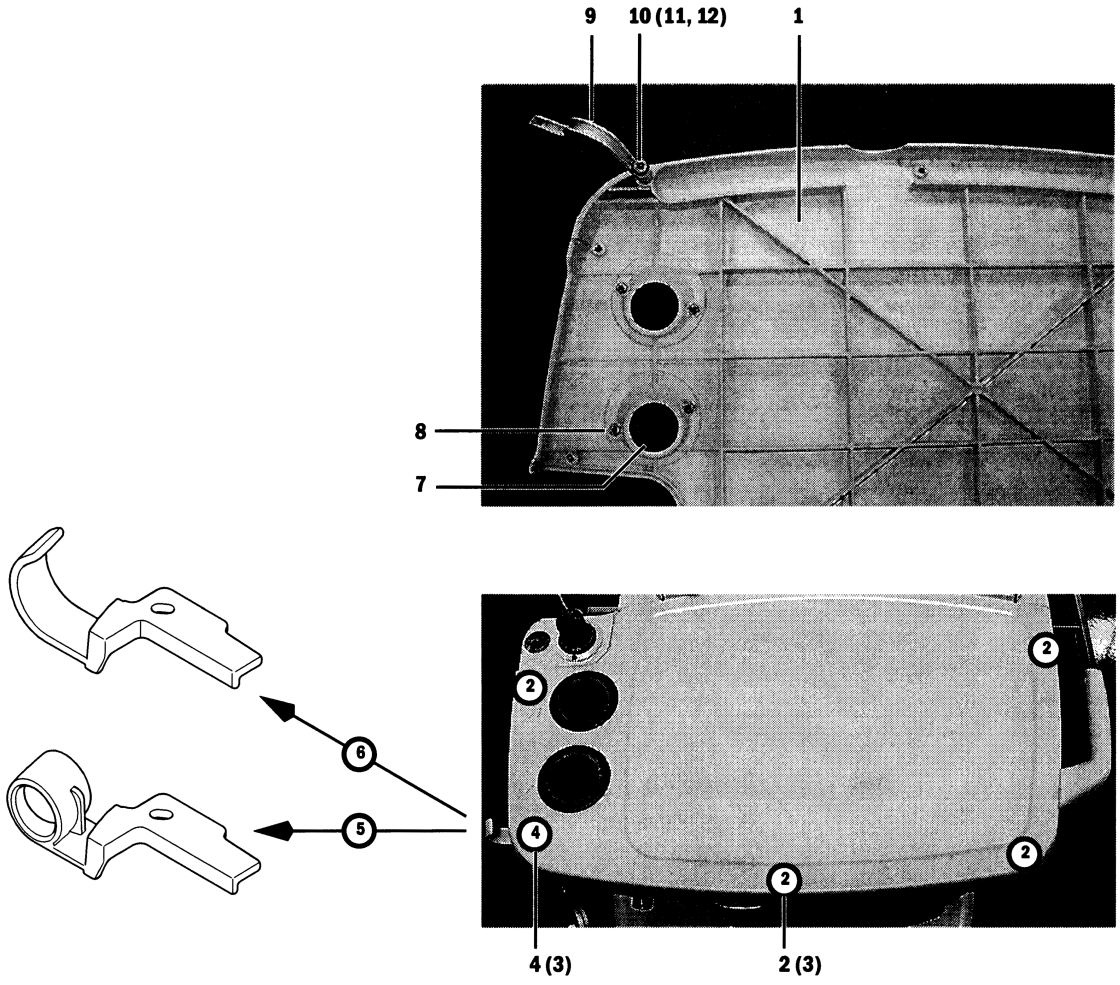
10.8 Rear panel components



Item	Description	Stock Number
1	Cover, rear upper	1009-3073-000
2	Cap, hose reel	1009-3075-000
3	Screw, M5.5x20	1009-3384-000
4	Strap, hook/loop	1009-3233-000
5	Screw, M6x1.0 captive	1009-3114-000
6	Door, access (not functional for Aespire)	1009-3074-000
7	Screw, M4x12	1009-3109-000
8	Spring, cantilever	1009-3124-000
9	Screw, M3x8	0142-4254-106
10	Cover, trap bottle (if no internal suction)	1009-3173-000
11	Cover, regulator yoke (if no regulator)	1009-3121-000
12	Plate, clip cover	1009-3185-000
13	Wrench, DIN cylinder (without cable)	1202-3651-000
14	Wrench, pin index cylinder (with cable)	0219-3415-800
15	Cable	1010-3049-000
16	Ferrule, cylinder wrench cable retainer	1001-3708-000
17*	Handle, P-grip	1009-3343-000

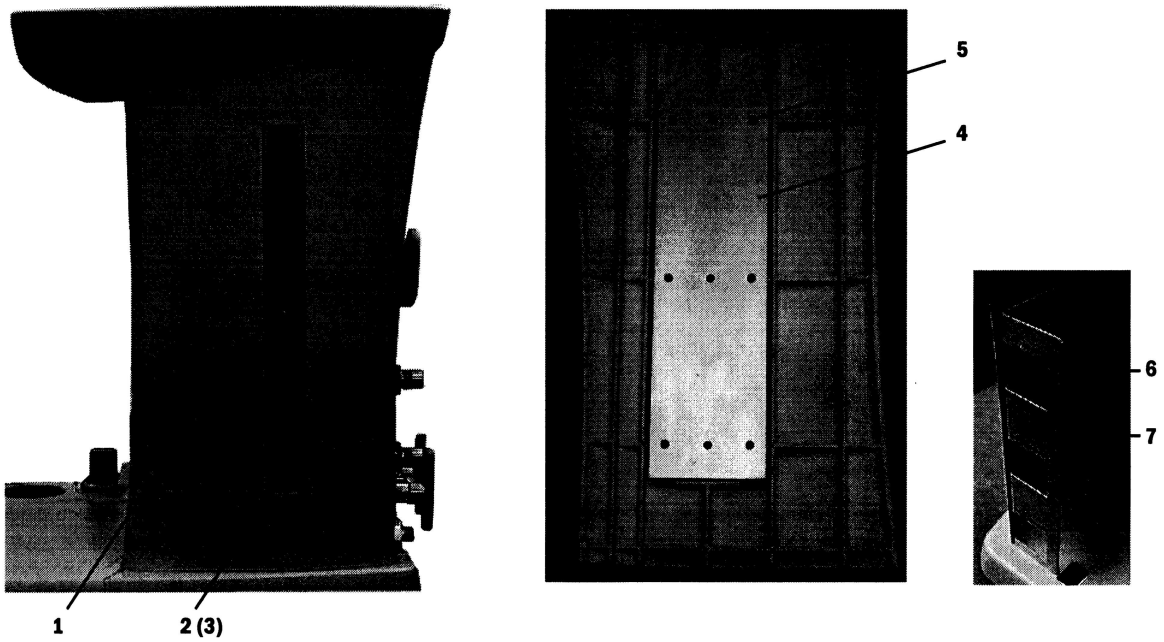
* Clean mounting surface with isopropyl alcohol.

10.9 Tabletop components



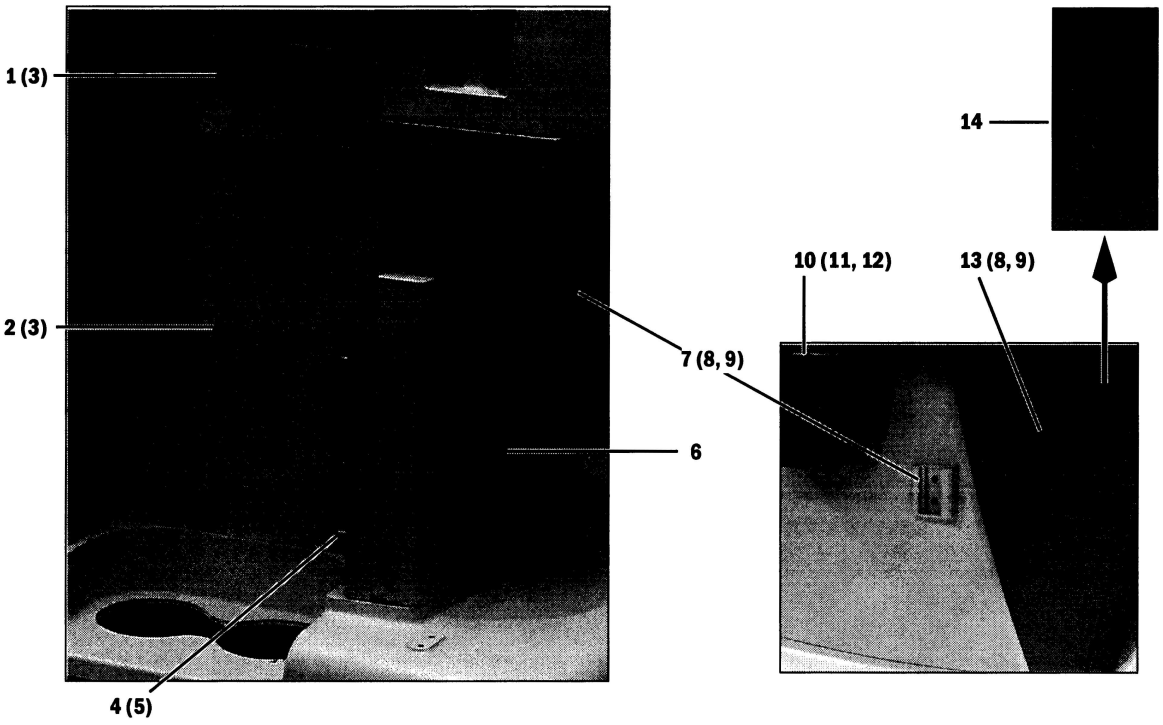
Item	Description	Stock Number
1	Tabletop, work surface	1009-3029-000
2	Screw, relieved M4x12	1504-3001-000
3	Washer, retainer	1009-3178-000
4	a: Screw, relieved M4x16 b: Washer, M5 flat	1011-3980-000 1006-1459-000
5	Clip (used with bag arm)	1009-3142-000
6	Clip (used with bag on tube)	1009-3139-000
7	Window, check-valve	1009-3088-000
8	Palnut	1009-3090-000
9	Hook, breathing circuit	1009-3086-000
10	Bolt, shoulder	1009-3172-000
11	Washer, wave	1009-3035-000
12	Washer, Nylon	1009-3150-000

10.10 Right-side Components



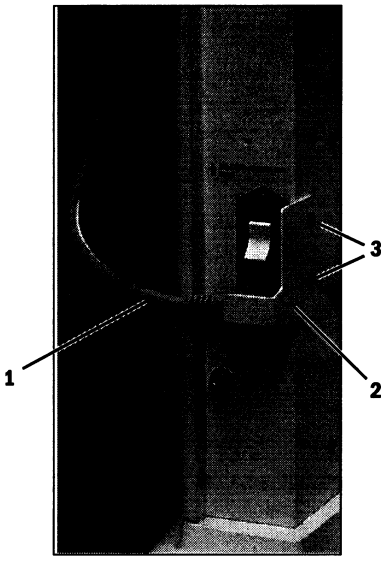
Item	Description	Stock Number
1	Extrusion cover	1009-3021-000
2	Screw, M6x20	0144-2131-921
3	Lockwasher, M6 internal	0144-1118-130
4	Dovetail, RH upright	1009-3129-000
5	Screw, M4x10 self-tapping	1009-5534-000
6	Cover, pipeline inlet	1009-3091-000
7	Screw, M4x8	1006-3178-000

10.11 External components - lower assembly

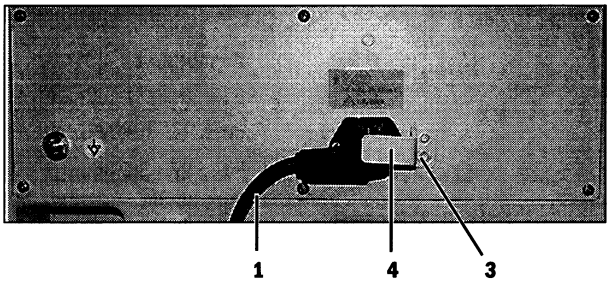


Item	Description	Stock Number
1	Panel, access	1009-3059-000
2	Panel, service	1009-4141-000
3	Screw, M4x8	1006-3178-000
4	Thumbscrew	1406-3304-000
5	Ring, retaining	1406-3319-000
6	Cover, scavenger reservoir	1009-3027-000
7	Bracket, suction reservoir	1009-3107-000
8	Screw, M4x16	9211-0440-163
9	Lockwasher, M4 external	9213-0540-003
10	Clip, suction bag hose	1407-3327-000
11	Screw, M5x16 PAN HD	9211-8350-163
12	Lockwasher, M5 external;	0144-1118-220
13	Bumper, absorber	1009-3105-000
14	Label, CO_2 canister	1011-3946-000

10.12 AC Power cords



Aespire 100 machine

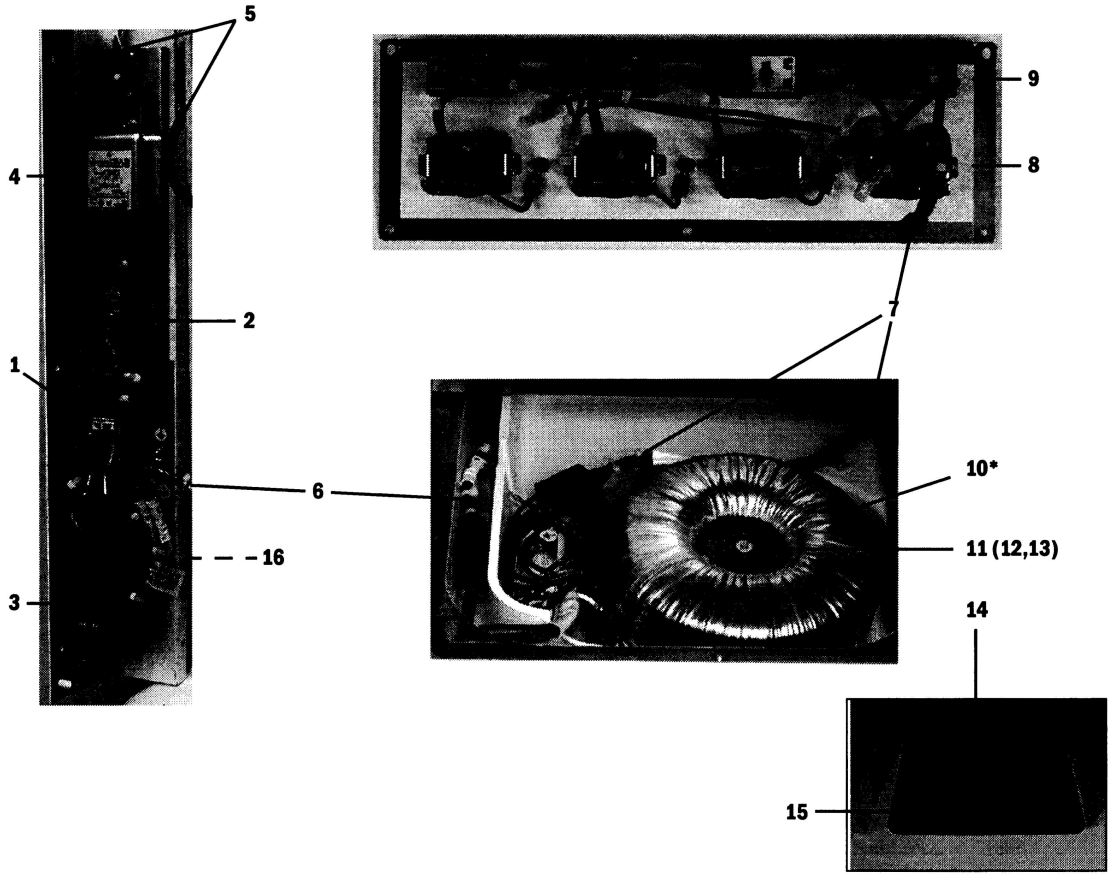


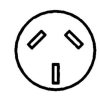
Item	Description	Stock Number
1	Power Cord	
	Australia, 220-240 VAC AS 3112	1006-3888-000
	China, 220-240 VAC AS 3112	M1053942
	Danish, 220-240 VAC	1011-3696-000
	EURO and France, 220 VAC CEE 7/7	1001-3380-000
	India and South Africa, 220-240 VAC BS546	1006-3885-000
	Japan and US, 100-120 VAC NEMA	1006-3907-000
	Peru, 220-240 VAC NEMA	1006-3882-000
	Swiss, 220-240 VAC SEV 1011	1006-3889-000
	UK, 220-240 VAC BS1363	1006-3884-000
2	Clamp, power cord retainer (All except China)	1009-3103-000
	Clamp, power cord retainer (China)	M1054192
3	Screw, M4x8 PAN serrated	1006-3178-000
4	Clamp, power cord retainer (All except China)	1009-3405-000
	Clamp, power cord retainer (China)	M1057453

10.13 AC Inlet/Outlet Components

Item	Description	Stock Number
1	Inlet, 100/120 AC, with line filter and 15 A circuit breaker	1009-5698-000
	Inlet, 220/240 AC, with line filter and 8 A circuit breaker	1009-5757-000
2	Fuse, 2A - 5x20mm	1009-5778-000
	Fuse holder	1009-5674-000
3	Circuit board, Inrush, 100-120V	1006-3245-000
	Circuit board, Inrush, 220-240V	1006-3246-000
	Circuit board, Transient Suppression, 100-120V	1006-3788-000
	Circuit board, Transient Suppression, 220-240V	1006-3789-000
4	Filter, AC Line, 100-240V	1009-5675-000
5	Cable, line filter to Display Module	1009-5711-000
6	Harness, 100/120 V to Toroid (or to outlets harness)	1009-5713-000
	Harness, 220/240 V to Toroid (or to outlets harness)	1009-5714-000
	Harness, if no outlets	1009-5715-000
7	Harness, to 100/120 V outlets	1009-5716-000
	Harness, to 220/240 V outlets	1009-5717-000
8	Outlet Receptacle, Australia, AS 3112	1001-3305-000
	Outlet Receptacle, Danish, AFSNIT 107-2-01	1011-3910-000
	Outlet Receptacle, EURO, CEE 7/7	1202-3551-000
	Outlet Receptacle, France, CEE 7/4	1006-4421-000
	Support Frame, snap in	1006-4422-000
	Outlet Receptacle, India and South Africa, BS 546	1006-3805-000
	Outlet Receptacle, Japanese	1006-3578-000
	Outlet Receptacle, NA, Nema 5-15	1006-3555-000
	Outlet Receptacle, Swiss, SEV 1011	1006-3807-000
	Outlet Receptacle, UK, BS1363	1001-3309-000
9	Circuit Breaker, 1A, Rocker	1009-5722-000
	Circuit Breaker, 2A Rocker	1009-5721-000
	Circuit Breaker, 3A Rocker	1009-5720-000
	Circuit Breaker, 4A Rocker	1009-5719-000
10*	Toroid, 100-240V	1009-5692-000
	Heatshrink tubing	1202-3268-000
11	Screw, M6x70	0144-2131-923
12	Lockwasher, M6	9213-0560-003
13	Washer	0402-1107-500
14	Cover, transformer	1009-3063-000
15	Screw, M4x8 DIN84 (for transformer cover)	1006-3178-000
16	Stud, Equal Potential, 6 mm	0208-0070-300

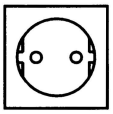
* Apply heatshrink tubing to terminals of black and white wires if not being used.





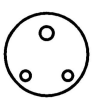
AS 3112/GB2009
Australia/China

AFSNIT 107-2-01
Danish



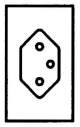
CEE 7/7
EURO

CEE 7/4
France

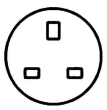


BS 546
India and South Africa

Nema 5-15
Japanese



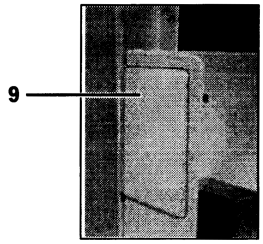
SEV 1011
Swiss,

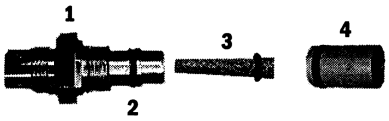


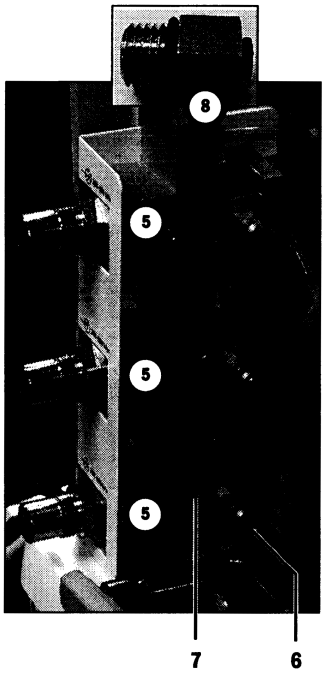
BS1363
UK

Nema 5-15
NA

10.14 Pipeline inlet fittings

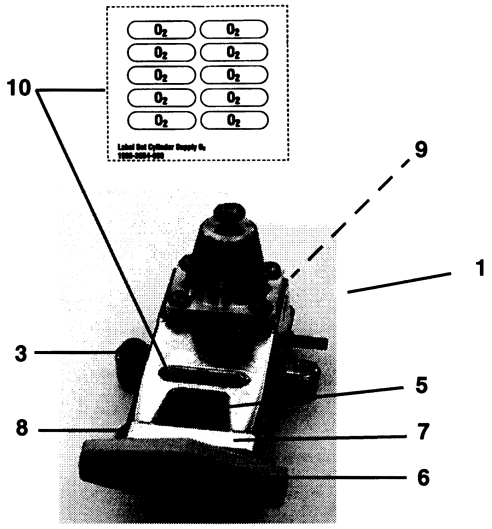


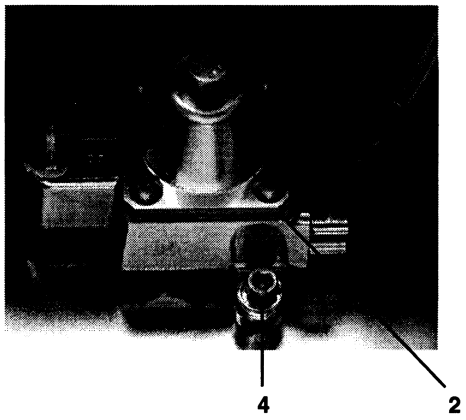




Item	Description		Stock Number
1	**Pipeline inlet - O_2 fittings**		----------
	Body, O_2 DISS		1006-5149-000
	Body, O_2 NIST		1006-5158-000
	Body, O_2 DIN		1006-5161-000
	Body, O_2 G 3/8 BSPP		1006-5170-000
	Pipeline inlet assembly O_2 France		1006-8363-000
	Pipeline inlet assembly O_2 Canada		1006-8360-000
	Pipeline inlet assembly O_2 Australia		1006-8396-000
1	**Pipeline inlet - N2O fittings**		----------
	Body, N_2O DISS		1006-5150-000
	Body, N_2O NIST		1006-5159-000
	Body, N_2O DIN		1006-5162-000
	Body, N_2O G 3/8 BSPP		1006-5171-000
	Pipeline inlet assembly N_2O France		1006-8362-000
	Pipeline inlet assembly N_2O Canada		1006-8359-000
	Pipeline inlet assembly N_2O Australia		1006-8397-000
1	**Pipeline inlet Air fitting**		----------
	Body, Air DISS		1006-5151-000
	Body, Air NIST		1006-5160-000
	Body, Air DIN		1006-5163-000
	Body, Air G 3/8 BSPP		1006-5172-000
	Pipeline inlet assembly Air France		1006-8361-000
	Pipeline inlet assembly Air Canada		1006-8358-000
	Pipeline inlet assembly Air Australia		1006-8398-000
2	O-ring, bore seal		----------
	O_2 and N_2O		0210-0479-300
	Air		0210-0539-300
3	Sintered metal filter with o-ring		1006-8351-000
4	Pipeline checkvalve with o-ring		1505-3273-000
5	Gas Inlet Manifold (replacement)	O_2	1009-8066-000
		N_2O	1009-8067-000
		Air	1009-8068-000
6	Relief valve, 758 kPa (110 psi)		1011-3049-000
7	Screw, M4x20		0144-2124-218
	Lockwasher, M4 external		9213-0540-003
8	Adapter, pressure gauge (with o-ring)		M1082611
	O-ring		0210-0533-300
9	Label, pipeline inlet blank		1009-3197-000

10.15 Cylinder Gas Supplies



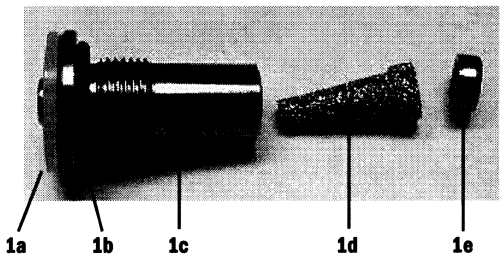


Item	Description	Pin Index (Inboard)	DIN (Inboard)	DIN, Large Cylinder (Inboard)
1	Gas supply O_2	1006-3201-000	1006-3207-000	1006-3880-000
1	Gas supply N_2O	1006-3225-000	1006-3208-000	1006-3881-000
1	Gas supply Air	1006-3203-000	1006-3209-000	-----
		Pin Index (Outboard)		
2	Gas supply N_2O	1009-8210-000		

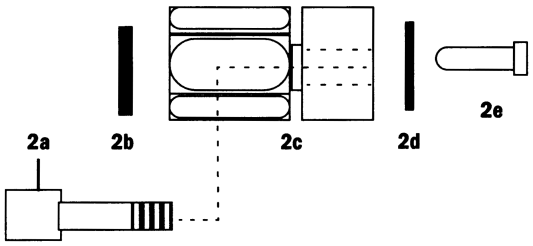
Item	Description	Stock Number
3	Standoff (3 per supply)	1009-3085-000
	Screw, M6x80 socket head cap (3 per supply)	0144-2131-913
	Lockwasher, M6 external (for above screw)	9213-0560-003
4	Screw, M6x25 socket head cap (3 per supply)	9211-0660-254
	Lockwasher, M6 external (for above screw)	9213-0560-003
5	Cylinder inlets (Pin Index or DIN for external cylinder)	Refer to section 10.15.1
6	Tee handle beige	0219-3372-600
7	Clamp, yoke	1001-4076-000
8	Spacer, gas block (2)	1001-4077-000
	Screw, M8 x 25 long socket head cap (2)	9211-0680-253
9	Elbow fitting for cylinder pressure gauge (copper tube connection of gas supply)	1006-3713-000
10	Label Set, cylinder supply, O_2	1006-3854-000
	Label Set, cylinder supply, N_2O	1006-3855-000
	Label Set, cylinder supply, Air	1006-3856-000

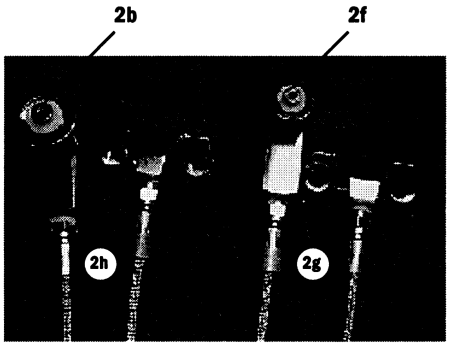
10.15.1 Cylinder inlet fittings

1 Pin Index



2 DIN (external cylinder)

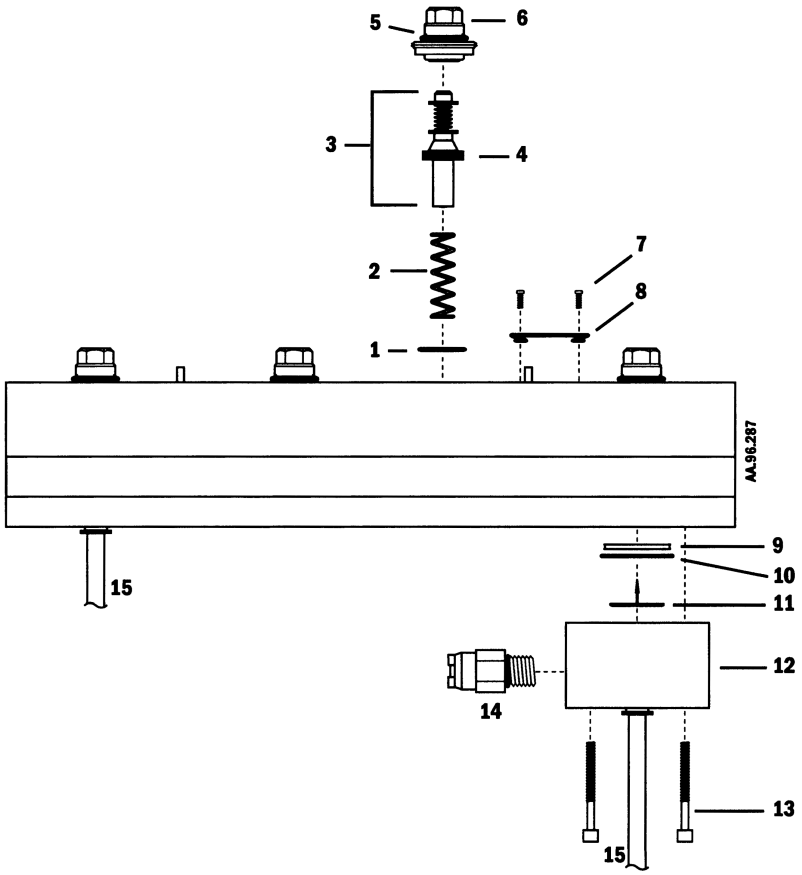




Item		Description	Stock Number
1		**Cylinder inlets (Pin Index)**	----------
	1a	Gasket	0210-5022-300
	1b*	O-ring	9221-3013-116
	1c	Adapter, inlet	1001-4075-000
	1d	Filter, sintered bronze	9914-6380-000
	1e	Retaining ring, filter	1001-5954-000
2		**Cylinder inlets (DIN)**	----------
	2a	Screw, M8x16	0144-2140-242
	2b	Sealing ring (DIN)	1009-3356-000
	2c	DIN Adapter (O_2)	1006-4000-000
		DIN Adapter (N_2O)	1006-4001-000
		DIN Adapter (Air)	1006-4002-000
	2d	O-ring, 0.687 ID, 0.812 OD	0210-0544-300
	2e	Filter, sintered bronze	9914-6380-000
	2f	Sealing ring, N_2O DIN Conn 11	1202-3641-000
	2g	Adapter, large cylinder N_2O	1006-4028-000
	2h	Adapter, large cylinder O_2	1006-4027-000

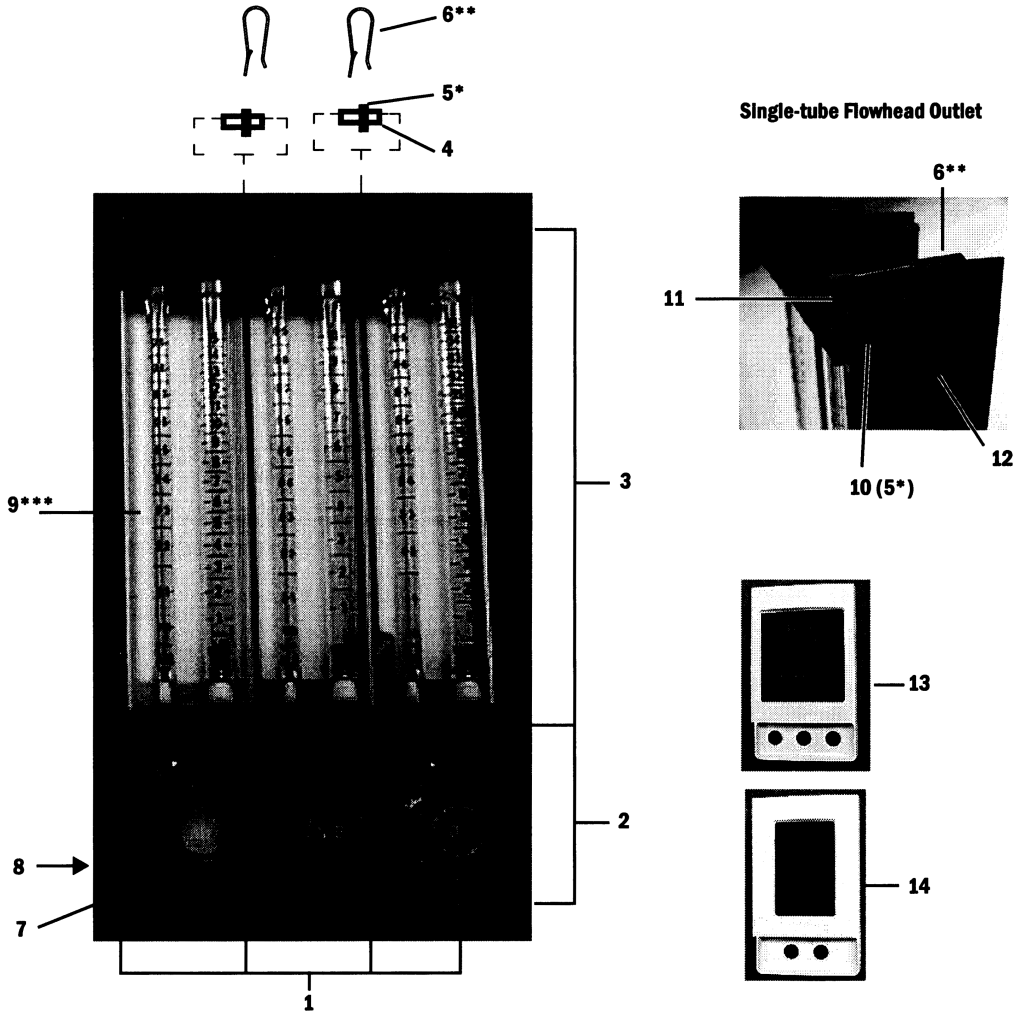
* Lubricate sparingly with Krytox

10.16 Vaporizer manifold



Item	Description	Stock Number
	Manifold assembly, complete, two position	1006-8355-000
	Manifold assembly, complete, one position	1009-8065-000
1	O-ring, 0.687 inch ID 0.812 inch OD	0210-0544-300
2	Spring, compression	1006-3736-000
3	Valve kit, includes seal	1006-8373-000
4	Seal	1006-3690-000
5	O-ring, 14.3 mm ID	1102-3043-000
	(Package of 6 o-rings)	1102-3016-000
6	Nipple, vaporizer port (New Style)	1006-4215-000
7	Screw, M2.5 - 0.45x6 PAN, Pozidriv, SST	1006-3037-000
8	Spring, Dzus	1102-3056-000
9	Seat, check valve	1006-1352-000
10	O-ring 27.1 OD 21.89 mm ID	1006-3866-000
11	Flapper	0211-1451-100
12	Housing	1009-8477-000
13	Screw, M4 x 30, cap head	9211-0640-304
14	Valve, relief, 5.5 psi, 7/16-20 THD	1006-4128-000
15	Flexible tubing, 1/4 inch, mixed gas	1001-3064-000

10.17 Flowmeter components



Item	Description	Stock Number
1	**Flowhead Module:** includes regulator, flowtube module, flowtubes, needle valve, intermodule tube and associated o-ring, and label plate; does not include labels, link-25, or knobs (order separately).	----------
	O_2 flowhead module with dual flowtubes	1006-8380-000
	N_2O flowhead module with dual flowtubes	1006-8381-000
	Air flowhead module with dual flowtubes	1006-8383-000
	Air flowhead module with dual flowtubes (manifold without regulator)	1009-8405-000
	Air flowhead module with single flowtube	1006-8382-000
	Air flowhead module with single flowtube (manifold without regulator)	1009-8404-000
2	Secondary regulators/Balance Regulators	----------
	Regulator Kit, O_2 (adjustable), without pressure switch	1006-8341-000
	Regulator Kit, N_2O (pressure balancing)	1006-8344-000
	Regulator Kit, Air (adjustable)	1006-8340-000
	Needle Valve Manifold Kit, Air (without regulator)	1006-8322-000

Item	Description	Stock Number
3	**Flowtube Module:** includes housing, o-rings, and plug ball; does not include, flowtubes, label or label panel (order separately).	----------
	Flowtube module, O_2 - dual	1006-8338-000
	Flowtube module, N_2O - dual	1006-8337-000
	Flowtube module, Air - dual	1006-8333-000
	Flowtube module, Air - single	1006-8334-000
4	Tube, intermodule connector	1006-3628-000
5*	O-ring, intermodule connector	1006-3613-000
6**	Clip, U-type self retaining	1006-4350-000
7	Screw, M5x30 (module mounting)	1102-3049-000
8	Screw, M5x55 (O_2/N_2O/3rd gas module connect)	1006-3607-000
	Screw, M5x110 (O_2 - Air module connect)	1006-3080-000
	Washer, M5 (O_2 - Air module connect)	1006-1459-000
	Nut, M5 Keps (O_2 - Air module connect)	0144-3717-324
9***	Flowmeter labels	refer to chart below
	Label panel, flowmeter module	1006-1290-000
	Side panel, (O_2 - Air flowmeter module)	1009-3186-000
	Screw, label panel	1006-3608-000
10	Adapter, single-tube outlet	1009-3056-000
11	Clip, small	1009-3309-000
12	Elbow, 1/4 inch	1202-3804-000
13	Bezel, flowmeter 3-gas	1009-3104-000
14	Bezel, flowmeter 2-gas	1009-3108-000

* Lubricate sparingly with Krytox.

** Note orientation of item 6; with flowmeter facing forward, the barbs should face to the left.

*** Position the label on the panel so that the right edge of the label is flush with the right edge of the panel. The left edge of the label will extend slightly beyond the left edge of the panel. When mounted in the flowmeter module, the flowmeter label on the right should slightly overlap the flowmeter label directly to its left.

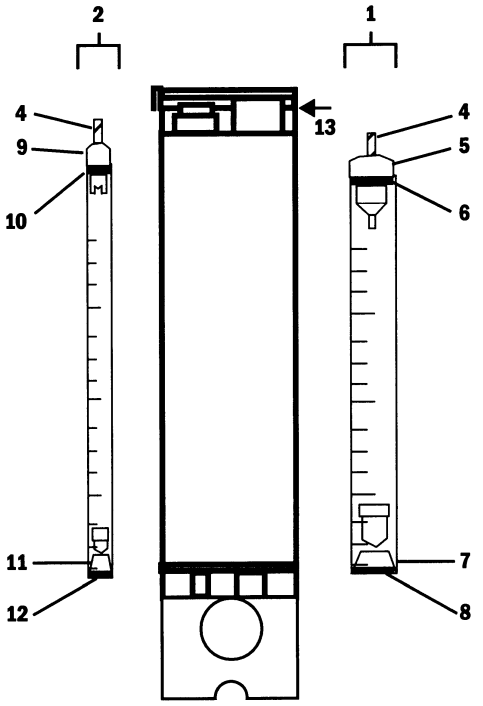
**** The O_2 label set contains a label for both the dual-tube **(A)** and single-tube (**B**) modules. Make sure to install the correct label.

Chart: Flowmeter Labels (Include knob labels)

	Stock Number	Stock Number	Stock Number
ANSI	**Air (Yellow)**	**N_2O (Blue)**	**O_2 (Green)**
	1006-0209-000	1009-3209-000	1009-3210-000
ISO	**O_2 (Neutral)**	**N_2O (Blue)**	**Air (Black/White)**
	1009-3211-000	1009-3209-000	1009-3242-000
Neutral	**O_2 (Neutral)**	**N_2O (Neutral)**	**Air (Neutral)**
	1009-3211-000	1009-3240-000	1009-3240-000

10.17.1 Flowtube parts

Item	Description	Stock Number
1	**Large flowtube kits** (includes float, filter, o-rings, tube)	----------
	Flowtube kit, Air, large	1006-8325-000
	Flowtube kit, N_2O, large	1006-8329-000
	Flowtube kit, O_2, large	1006-8331-000
2	**Small flowtube kits** (includes float, filter, o-rings, tube)	----------
	Flowtube kit, Air, small	1006-8326-000
	Flowtube kit, N_2O, small	1006-8330-000
	Flowtube kit, O_2, small	1006-8332-000
3	**Single-tube flowtube kits** (includes float, filter, o-rings, tube)	----------
	Flowtube kit, single-tube Air flowmeters use the Large flowtube kits	
	Flowtube kit, N_2O, single-tube, dual-taper with filter	1009-8199-000
	Flowtube kit, O_2, single-tube, dual-taper with filter	1009-8198-000
4	Spring, top of flowtubes	1006-3624-000
5	Float stop, O_2 large	1006-1225-000
	Float stop, N_2O large	1006-1226-000
	Float stop, Air large	1006-1227-000
6	O-ring, 17.6 OD, 12.37 ID, large flowtube, top	1006-3615-000
7	Filter, large flowtube	1006-3584-000
8	O-ring, 17.6 OD, 12.37 ID, large flowtube, bottom (red)	1006-3968-000
9	Float stop, O_2 small	1006-1233-000
	Float stop, N_2O small	1006-1234-000
	Float stop, Air small	1006-1235-000
10	O-ring, 11.26 OD, 6.02 ID, small flowtube, top	1006-3617-000
11	Filter, small flowtube	1006-3583-000
12	O-ring, 11.26 OD, 6.02 ID, small flowtube, bottom (red)	1006-3969-000
13	Ball, 6 mm (plug fresh gas end)	1006-1353-000
Not Shown:		
	O-ring Kit, flowtubes (includes 4 each of top and bottom o-rings for large flowtube and 3 each of top and bottom o-rings for small flowtube).	1006-8393-000
	Silicon tube kit, long, including cable ties	1006-8378-000
	Silicon tube kit, short, including cable ties	1006-8379-000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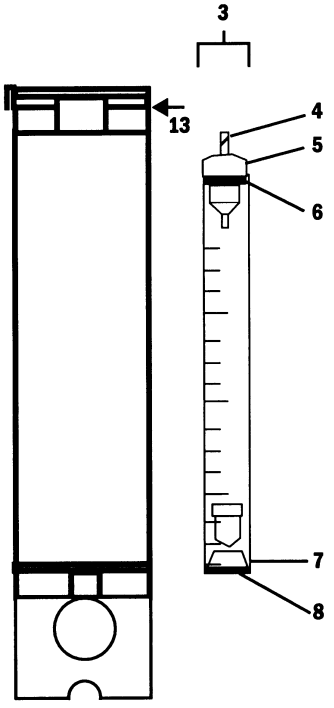
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10.17.2 Secondary regulator components

Item	Description	Stock Number
1	Knob (N_2O) (Air) without label	1006-3633-000
2	O_2 Proportioning assembly (includes knob, sprocket, set screws, without knob label)	1006-8339-000
3	Set screw	0141-4227-105
4	O_2 Proportioner chain	1006-3610-000
5	Sprocket, N_2O	1006-3625-000
6	Plug, 1/8 inch	1006-3611-000
7	Spacer, link system, N_2O needle valve	1006-5140-000
8	Valve, needle (O_2) (Air)	1006-8346-000
	Valve, needle N_2O (has notch around valve body)	1006-8345-000
9	O-ring, 10.1 ID 13.3 OD	9221-3010-116
10	O-ring, 0.250 inch ID 0.375 inch OD	0210-0687-300
11	Minimum stop collar (all gases)	1006-3632-000
12	Pressure switch, O_2 supply alarm	1006-3623-000
13	O-ring, 0.250 inch ID 0.375 inch OD	0210-0687-300
14	Screws, M4x12 Pozidriv PAN	0140-6226-111
15	Plug, pressure switch cavity	1006-3665-000
16	Screws, M4x8 Pozidriv PAN	1006-3178-000
17	Fitting, O_2 pilot, plug-in elbow	1006-3533-000
18	Fitting, O_2 pilot, thread-in elbow	1006-3663-000
19	Tubing, 4-mm (RH head 144 mm - LH head 164 mm)	1001-3060-000

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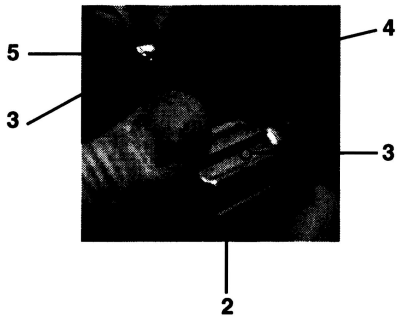
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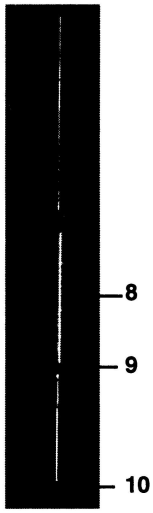
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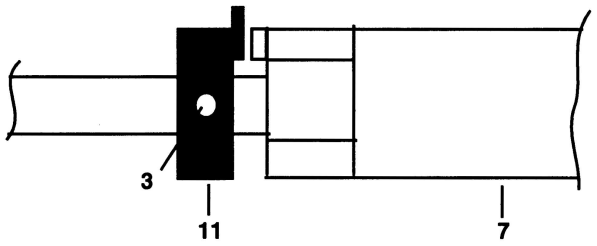
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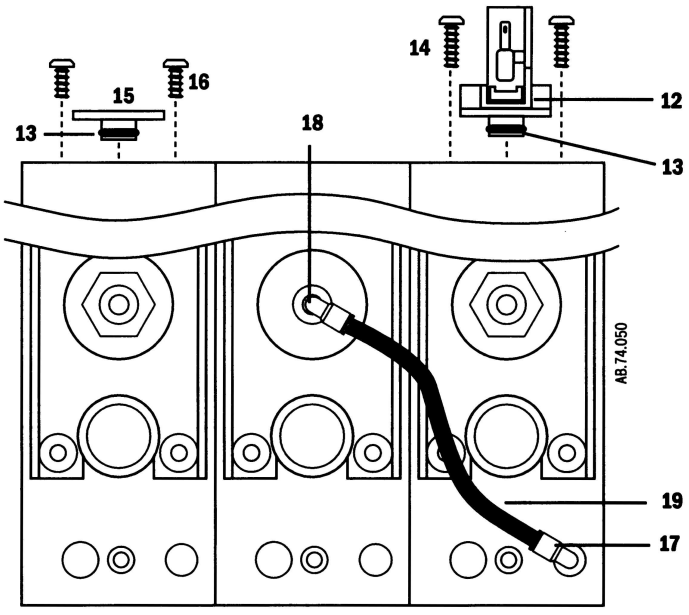
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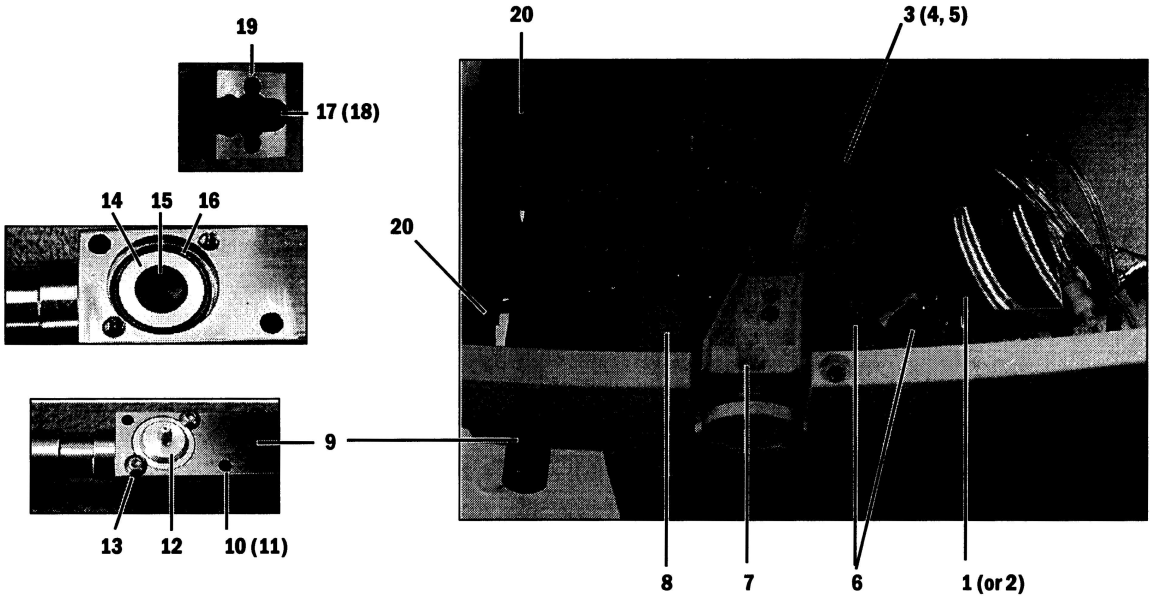
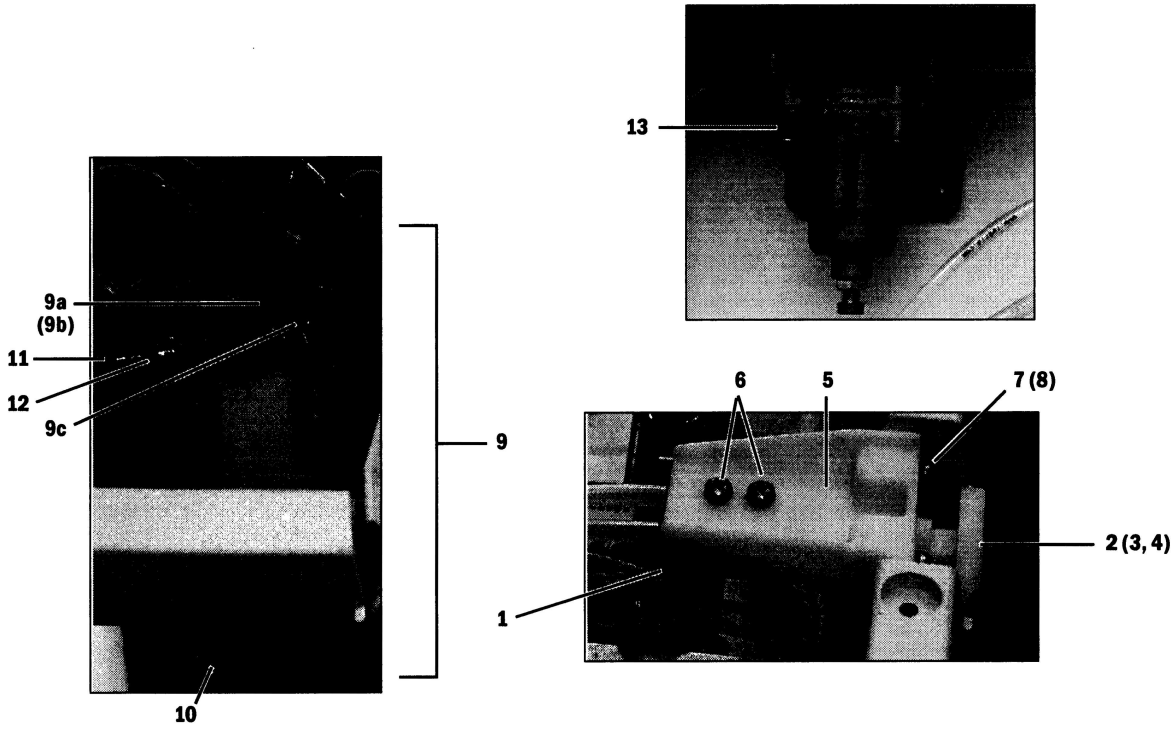
10.18 ABS to machine Interface Components



Item	Description	Stock Number
1	PCA VENT MONITORING Board [TESTED VMB]	1009-8002-000
2	PCA B/S task light interface board (used when no monitoring is ordered)	1009-5681-000
3	Screw, M4x16 PH PAN HD SST TYPE 316	9211-0440-163
4	Lockwasher, EXT M4 DIN 6797 SST TYPE 316	9213-0540-003
5	Spacer, 0.171 IN ID 0.250 IN OD 0.250 IN LG aluminum	1202-3693-000
6	Cables and harnesses	Refer to section 10.29
7	O_2 Flush Valve	Refer to section 10.18.1
8	ACGO Selector Valve	Refer to section 10.18.1
9	Port, ACGO body	1009-3096-000
10	Screw, M4x30	9211-0640-304
11	Lockwasher, M4	9213-0540-003
12	Cap, ACGO check valve	1009-3095-000
13	Screw, M4x8	9211-1040-069
14	Disk, ACGO check valve	1009-3062-000
15	Flapper, ACGO check valve	1009-3097-000
16*	O-ring	0210-0543-300
17	Fitting, elbow barbed	1009-3160-000
18*	O-ring	0210-0691-300
19	Screw, M3x6	9211-1030-055
20	Tie wrap	0203-5915-300

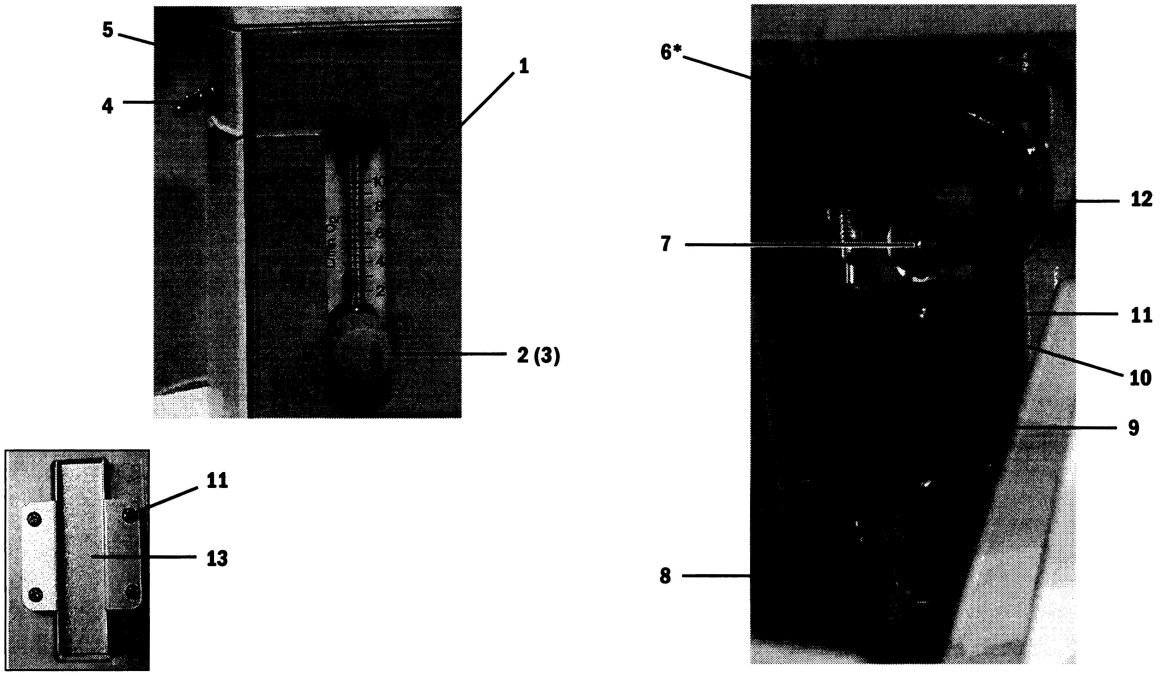
* Lubricate sparingly with Krytox.

10.18.1 Flush Regulator, Flush Valve, and ACGO Selector Switch



Item		Description	Stock Number
1		Flush valve, without button	1006-8357-000
2		Flush Button with rod	1011-3354-000
3		Spring	1006-3186-000
4		E-ring	0203-5225-300
5		Bracket	1011-3355-000
6		Screw, M4x8	1006-3178-000
7		Screw, M4x12	0140-6226-111
8		Lockwasher, M4	9213-0540-003
9		ACGO Selector Switch, complete (without guard - item 10)	1009-3099-000
	9a	Flush pressure switch	1006-3972-000
	9b	O-ring	1006-3213-000
	9c	Screws, M3x20	0144-2124-201
10		Guard	1009-3140-000
11		Tubing, silicone	1009-3164-000
12		Tie wrap	0203-5915-300
13		Regulator, O_2 Flush	1011-3168-000

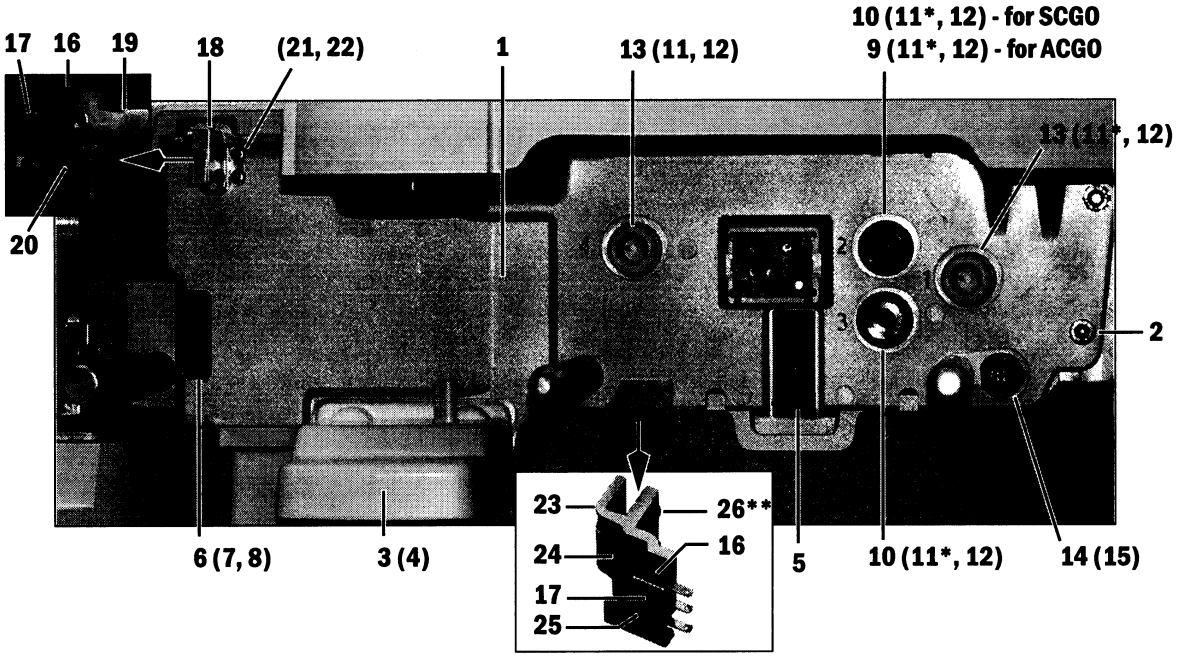
10.19 Auxiliary O_2 Flowmeter



Item	Description	Stock Number
1	Flowmeter, 1-10 L/min, Complete with fittings installed Flowmeter, 1-10 L/min, without fittings	1006-8424-000 1006-3841-000
2	Knob, gray	1011-3471-000
3	Set Screw	9211-0830-053
4	Nipple, Panel-Mount, Auxiliary O_2 Outlet	1006-5177-000
5	Label, blank (if no Auxiliary O_2)	1009-3243-000
6*	Nut, M12x1.75, SST	0144-3132-140
7**	Flowmeter Fitting, 1/8 NPTM straight adapter Flowmeter Fitting, 1/8 NPTM elbow adapter	0204-8877-300 0204-8788-300
8**	Flowmeter Fitting Assembly, 6-mm Tubing Adapter	1006-8423-000
9	Plate, Flowmeter Mounting	1009-3126-000
10	Screw, 10-32 x 3/8	0140-6631-107
11	Screw, M4x10 self-tapping	1009-5534-000
12	Tubing (low-pressure) 250 mm - 1/4 inch	1605-1001-000
13	Plate, blank (if no Auxiliary O_2)	1009-3128-000

* Apply Loctite 242.
** Apply Teflon tape.

10.20 Breathing system interface



Item	Description	Stock Number	Qty
1	Assembly, main support casting	1407-7010-000	
2	Bolt, M6x16 flange	1009-3125-000	(5)
3	Handle, grip	1407-3317-000	
4	Screw, M6X16 Sems	0144-2436-109	(2)
5	Latch, push to close	1407-3309-000	
6	Latch, push to close w/microswitch	1407-3310-000	
7	Screw, SKT HD CAP M3x8 SST	1006-3865-000	(2)
8	Washer, lock external M3	9213-0530-003	(2)
9	Port, plug circuit (ACGO)	1407-3333-000	
10	Port, fresh gas (SCGO)	1407-3314-000	
11*	Seal, U-Cup 12.7 ID BCG 19.05 OD EPR	1407-3320-000	(4)
12	Ring, retaining 15.88 SHAFT DIA TYPE E SST	1406-3446-000	(4)
13	Port, sample gas	1407-3318-000	(2)
14	Connector, bulkhead O2 Cell, with harness	1009-5586-000	
15	Ring, retaining 9.53 SHAFT DIA TYPE E SST	1406-3277-000	
16	Switch, subminiature w/QDISC terminals	1406-3296-000	(2)
17	Screw, M2.5 x10	1009-3153-000	(4)
18	Bracket, BTV switch	1407-3319-000	
19	Lever, BTV switch	1407-3325-000	
20	Bracket, cap BTV	1407-3324-000	
21	Screw, SKT HD CAP M3x8 SST	1006-3865-000	(2)
22	Washer, lock external M3	9213-0530-003	(2)
23	Bracket, bypass switch	1407-3139-000	
24	Paddle, switch actuator	1407-3141-000	
25	Bracket, paddle hinge	1407-3140-000	
26**	Screw, M6x6 set cup	1007-3329-000	(2)

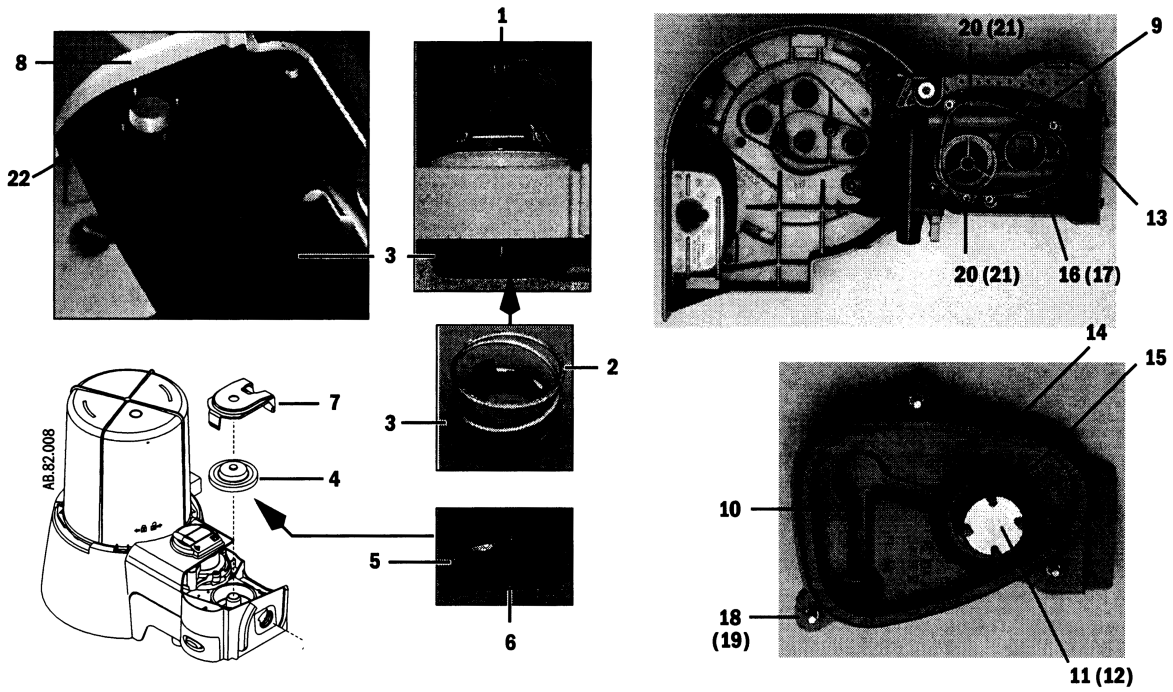
* Lubricate sparingly with Krytox.

** Apply Loctite 242.

Note: SCGO only applies to Avance and Aisys machines.

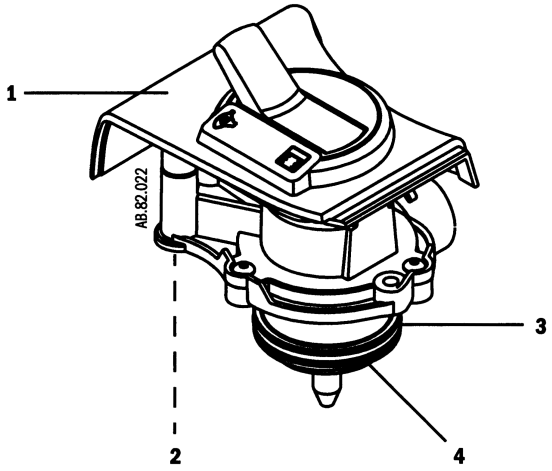
10.21 Breathing System

10.21.1 APL Valve



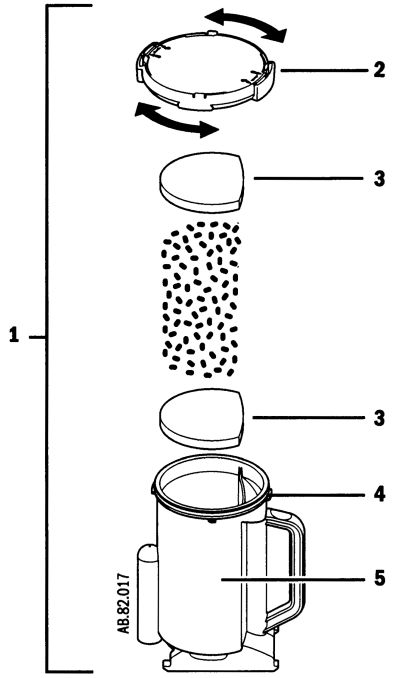
Item	Description	Stock Number	QTY
1	APL Valve Assy (includes items 2 through 6)	1009-8200-000	
2	SPRING CPRSN 53.14 OD 36.8 L 1.48 N/MM	1406-3328-000	
3	RETAINER SPRING APL	1407-3404-000	
4	DIAPHRAGM APL	1406-3331-000	
5	CAGE APL	1406-3333-000	
6	POPPET APL VALVE	1406-3332-000	
7	RAMP APL	1407-3400-000	
8	COVER APL	1407-3405-000	
9	MANIFOLD APL/BTV	1407-3401-000	
10	Cover, Manifold APL/BTV (with 22-mm male bag port)	1407-3402-000	
	Cover, Manifold APL/BTV (with Australian bag port - 22 mm female)	1407-3412-000	
11	WEIGHT DEAD 14CM H2O BCG ABS NEG RELIEF	1407-3406-000	
12	SEAL ABS NEG RELIEF VLV	1407-3407-000	
13	O-RING 22 ID 30 OD 4 W SI 40 DURO	1407-3104-000	
14	O-RING 88.49 ID 95.55 OD 3.53 W SILICONE 50 DURO	1407-3403-000	
15	O-RING 1.049ID 1.255OD .103W EPDM NO 121	1407-3408-000	
16	SCR M4X16 BT SKT HD SST TYPE 316	0140-6226-115	(2)
17	Lockwasher, M4 external	9213-0540-003	(2)
18	SCR THUMB M4 SHLDR 7.5 X 7	1407-3410-000	(3)
19	RING RETAINING 3.96 SFT DIA CRESCENT SST	1407-3411-000	(3)
20	SCR M4 X 40 FL HD SST PH	0140-6226-122	(2)
21	O-RING 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(2)
22	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(3)

10.21.2 Bag/Vent Switch



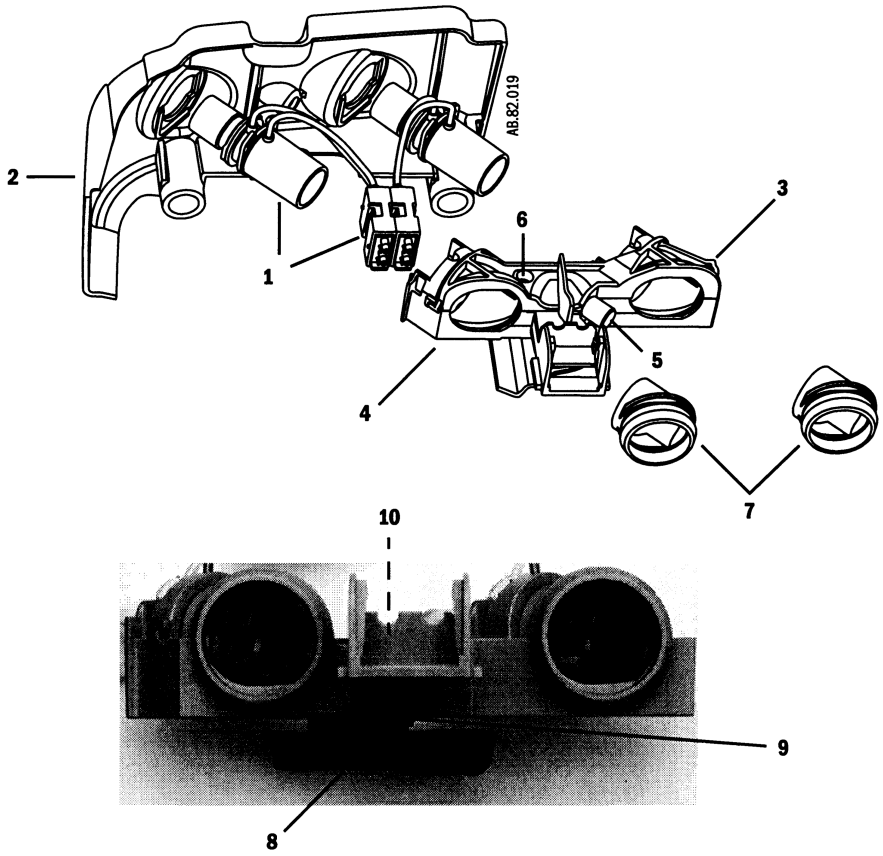
Item	Description	Stock Number	QTY
	BTV Switch Cartridge	1407-7003-000	
1	COVER BTV	1407-3500-000	
2	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(2)
3	O-RING 44.02 ID 51.1 OD 3.53 W SI 70 DURO	1407-3507-000	
4	SEAL, BTV	1407-3506-000	

10.21.3 Absorber canister



Item	Description	Stock Number	Qty
1	Multi-Absorber canister, reusable (does not include absorbent)	1407-7004-000	
2	Cover assembly, CO_2 canister	1009-8240-000	
3	Foam, CO_2 canister (pack of 40)	1407-3201-000	
4	O-ring	1407-3204-000	
5	Canister, CO_2	1407-3200-000	
---	Multi-Absorber canister, disposable (white to violet; pack of 6)	8003138	
---	Multi-Absorber canister, disposable (pink to white; pack of 6)	8003963	

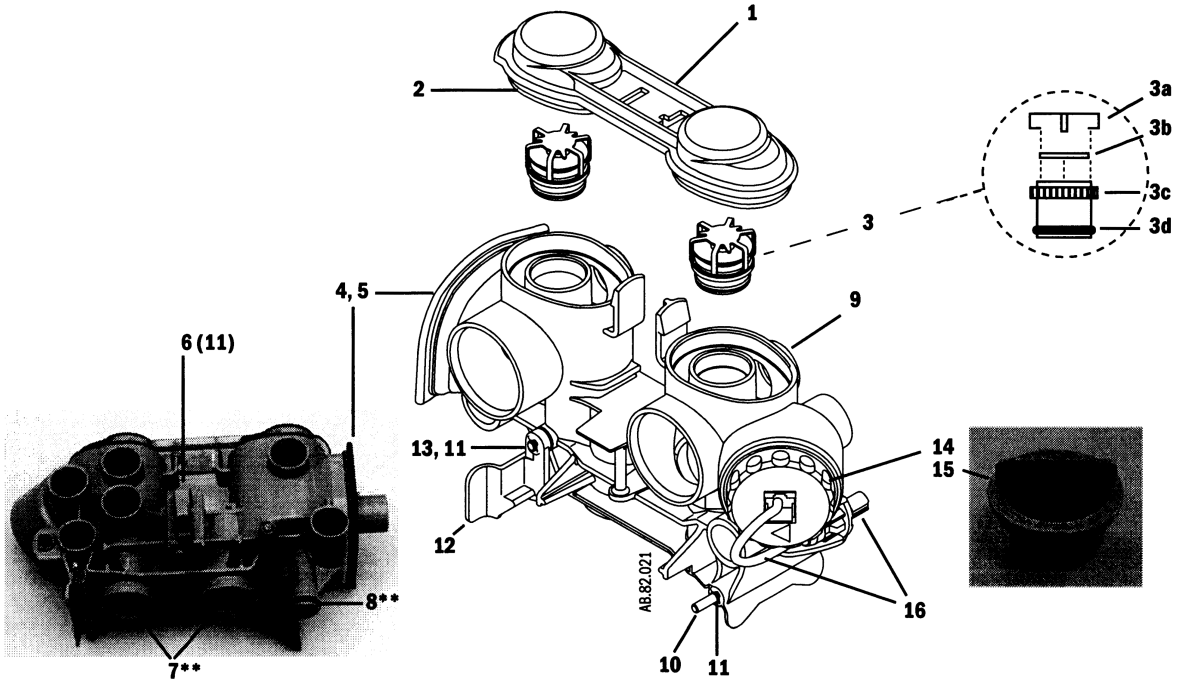
10.21.4 Flow Sensor Module



Item	Description	Stock Number	Qty
	Flow Sensor Module (*)	1407-7001-000	
1*	Flow Sensor (plastic - moisture resistant)	1503-3858-000	
	Flow Sensor (metal - autoclavable)	1503-3244-000	
	Flow Port Adapter	1503-3849-000	
2	Cover, Flow Sensor (Avance and Aespire machines)	1407-3000-000	
	Cover, Flow Sensor (Aisys machines)	1011-3283-000	
3	HOLDER FLOW SNSR UPPER	1407-3002-000	
4	HOLDER FLOW SNSR LOWER	1407-3003-000	
5	SCR THUMB M6X43 SST	1406-3304-000	
6	SCR M4 .07 X 10 SKT CAP BUTTON HEAD SST	0144-2117-718	(2)
7	CUFF FLOW SNSR	1407-3004-000	(2)
8	LATCH FLOW SNSR	1407-3001-000	
9	SPR TORSION FLOW SNSR LATCH	1407-3005-000	
10	RING TRUARC .188 SHAFT E-RING SST	0203-5225-300	

* The flow sensors are not included in the flow sensor module.

10.21.5 Breathing Circuit Module

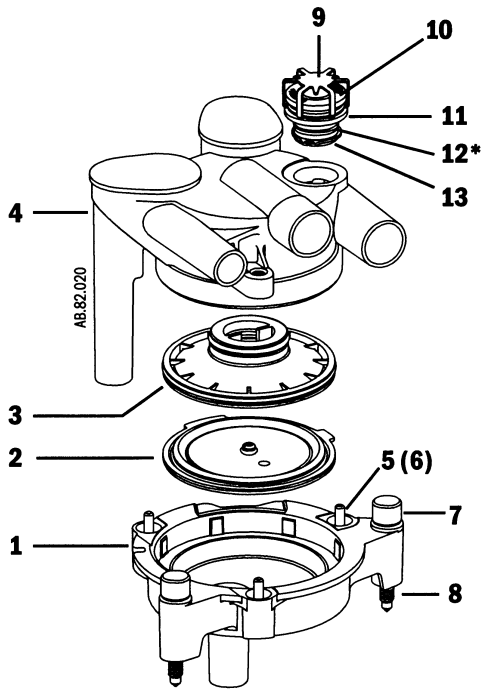


Item	Description	Stock Number	Qty
	Breathing Circuit Module *	1407-7002-000	
1	LENS CIRCUIT CHK VALVES	1407-3101-000	
2	O-RING 44.02 ID 51.1 OD 3.53 W SI 70 DURO	1407-3507-000	(2)
3	Check Valve Assembly	1406-8219-000	(2)
3a	RETAINER DISK 26.97D 12.7H 0.76T	1400-3017-000	(2)
3b	DISC CHK V RVSBL 1.025D	0210-5297-100	(2)
3c	SEAT UNIDIRECTIONAL V B/S	1406-3396-000	(2)
3d	O-RING 20.35 ID 23.90 OD 1.78W	1406-3397-000	(2)
4	PLATE CIRCUIT FLANGE	1407-3110-000	
5	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(6)
6	HOOK LATCH	1407-3604-000	
7**	O-RING 22 ID 30 OD 4 W SI 40 DURO	1407-3104-000	(2)
8**	O-RING 12.37 ID 17.6 OD	1006-3968-000	
9	MANIFOLD CIRCUIT	1407-3100-000	
10	PIN CANISTER PIVOT	1407-3109-000	
11	RING TRUARC .188 SHAFT NO 5133-18H E-RING SST	0203-5225-300	(5)
12	LEVER CANISTER LATCH	1407-3102-000	
13	PIN CANISTER LEVER	1407-3108-000	
14*	O_2 Cell (includes o-ring)	6050-0004-110	
	O-ring, cell	1406-3466-000	
15*	Plug with o-ring (for units without circuit O_2 sensing)	1503-3857-000	
	O-ring, plug	1406-3466-000	
16*	Cable, O_2 Cell	1009-5570-000	

* The O_2 cell (or plug) and the cell cable are not included in the breathing circuit module.

** Lubricate sparingly with Krytox.

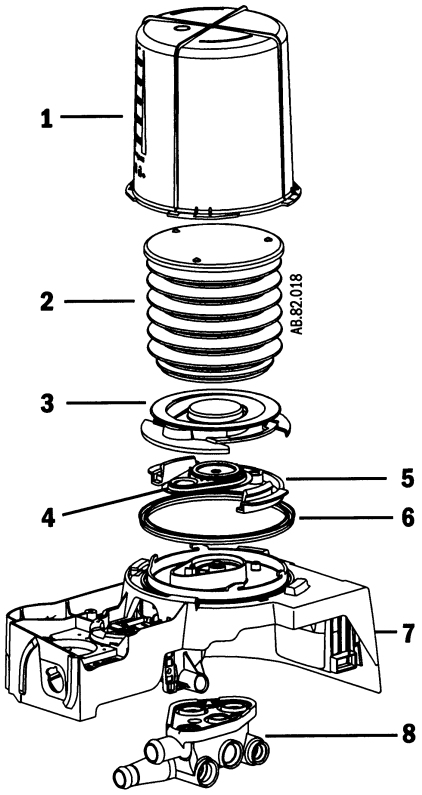
10.21.6 Exhalation valve



Item	Description	Stock Number	Qty
	Exhalation Valve assembly	1407-7005-000	
1	Base, exhalation valve	1407-3701-000	
2	Diaphragm assembly	1503-8121-000	
3	Seat, exhalation valve	1407-3704-000	
4	Cover, exhalation valve	1407-3700-000	
5	Screw, M4x16 PH PAN HD	9211-0440-163	(3)
6	O-ring, 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(3)
7	Thumbscrew, M6x43 10mm head	1406-3306-000	(2)
8	O-ring, 4.47 ID x 8.03 OD 1.78 W EPR 70 DURO	1407-3703-000	(2)
9	Retainer, disk 26.97D 12.7H 0.76T SST flutter	1400-3017-000	
10	Weight, dead 10 cm H2O	1406-3572-000	
11	Seat	1406-3571-000	
12*	O-ring, OD19.16 ID15.6 EPDM DURO 70 -016	1006-3616-000	
13	Ring, retaining 19.05 SHAFT DIA	1406-3577-000	

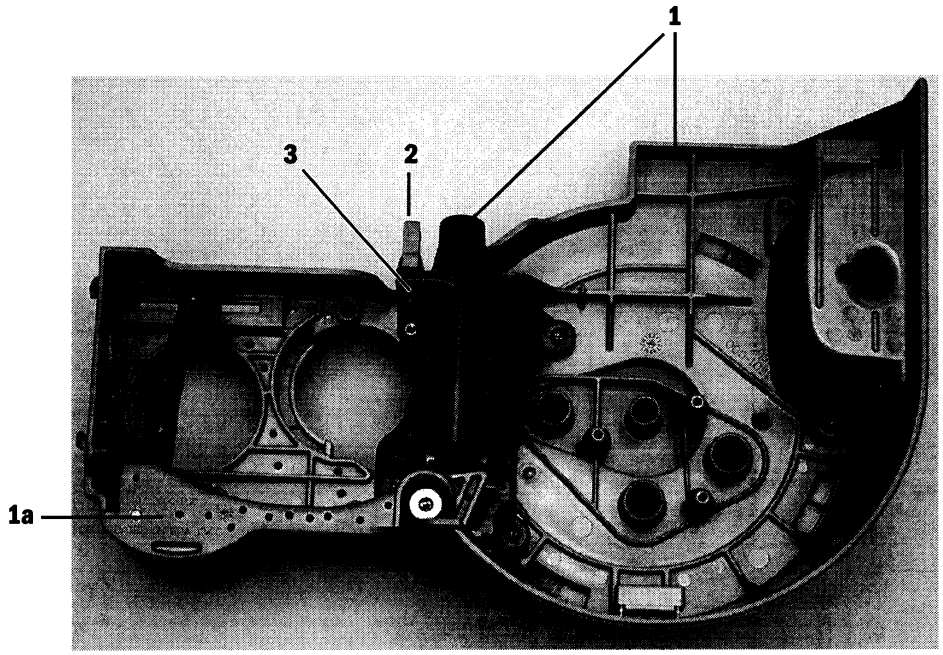
* Lubricate sparingly with Krytox.

10.21.7 Bellows



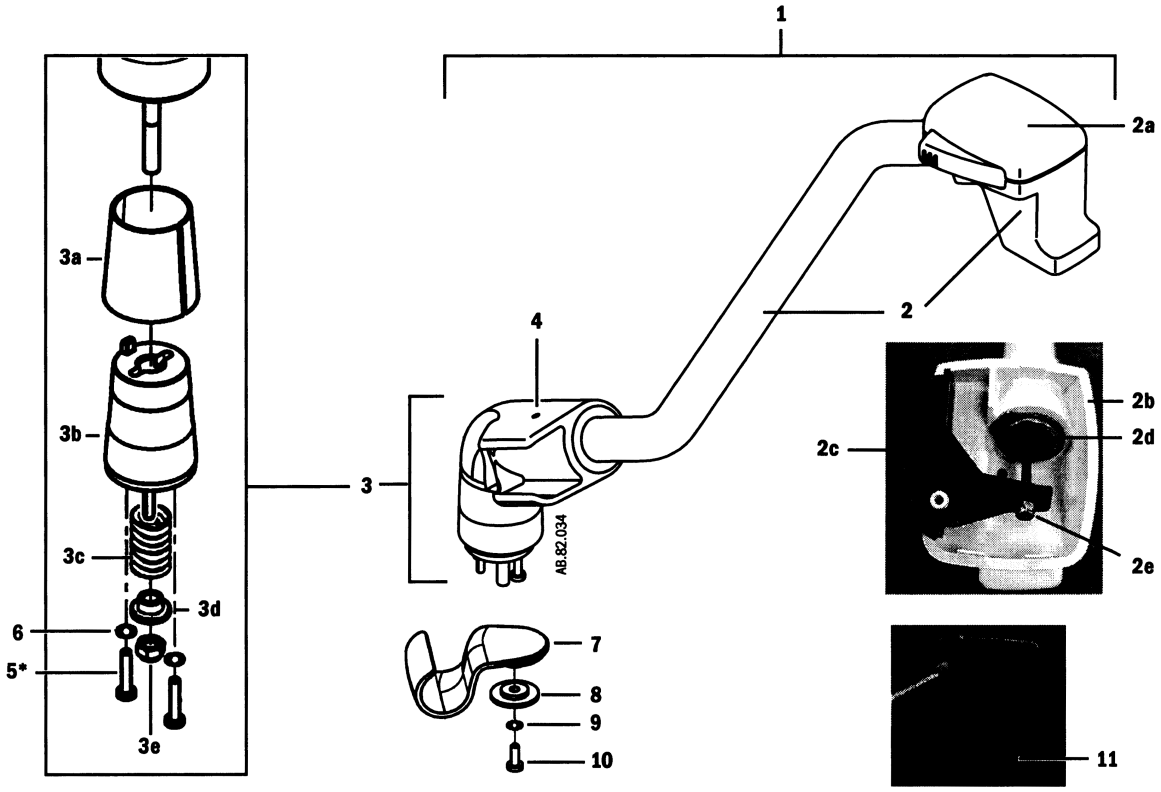
Item	Description	Stock Number
1	Bellows housing	1500-3117-000
2	Bellows	1500-3378-000
3	Rim	1500-3351-000
4	Pressure relief valve assy	1500-3377-000
5	Latch, base	1500-3352-000
6	Seal, base	1500-3359-000
7	Base, bellows	Refer to section 10.21.8
8	Manifold, bellows base	1407-3702-000

10.21.8 Bellow base



Item		Description	Stock Number
1		Bellows Base Assy	1407-7006-000
	1a	Latch Assy	1407-7007-000
2		HOOK LATCH	1407-3604-000
3		E-Ring	0203-5225-300

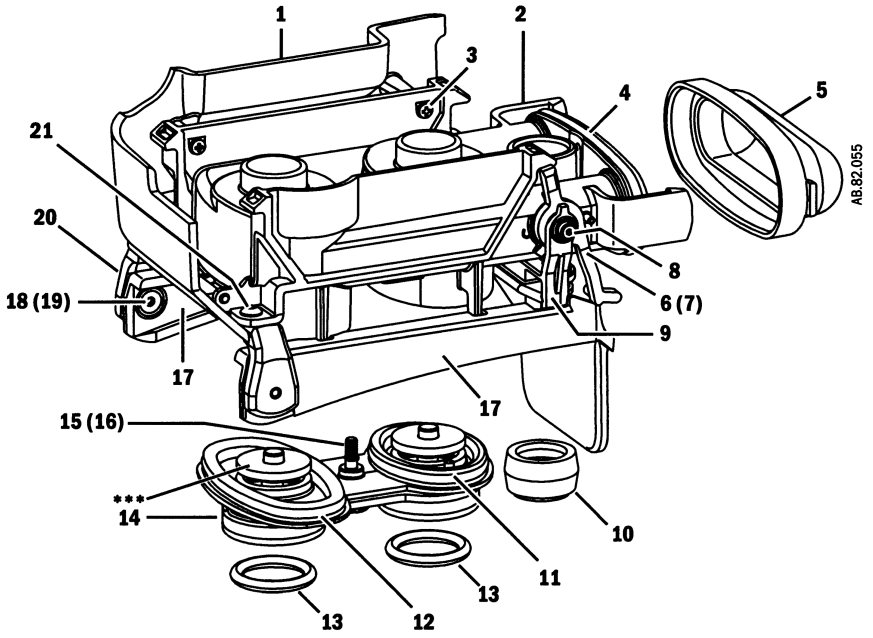
10.21.9 Bag Arms



Item		Description	Stock Number	Qty
1		Bag Arm Assembly (complete)	1009-8159-000	
2		Bag Arm Upper Assembly	1407-7011-000	
	2a	Cover, bag port housing	1407-3807-000	
		Screw, M3x20	0140-6719-103	
		Lockwasher, M3 internal	9213-0430-003	
	2b	Housing, bag port	1407-3806-000	
	2c	Lever, lock release	1407-3808-000	
	2d	Ring, retaining	1406-3577-000	
	2e	Nut, M3 Nyloc	0144-3536-112	
3		Bag Arm Lower Assembly	1407-7012-000	
	3a	Pad, Friction Material	----------	
	3b	Bag Arm post subassembly	----------	
	3c	Spring	----------	
	3d	Washer, shoulder	----------	
	3e	Nut, M5 Nyloc	----------	
4		Pin, dowel 3.18 DIA 31.8 L SST	1407-3804-000	
5*		Screw, M3x20 SKT HD CAP	0144-2124-201	(2)
6		Washer, M3 flat	0144-1003-132	(2)
Items if no Bag Arm				
7		Clip, patient tubing	1407-3810-000	
8		Washer, shoulder	1407-3814-000	
9		Lockwasher, M4 external	9213-0540-003	
10		Screw, M4x16	9211-0440-163	
Accessory Items				
11		Bag arm connector, reusable (All except China)	8004459	
		Bag arm connector, reusable (China)	M1082613	

* Apply Loctite 242.

10.21.10 EZchange Canister system (CO_2 Bypass)



Item	Description	Stock Number	Qty
	EZchange Canister module	1407-7021-000	
1	Cover, Bypass Manifold	1407-3123-000	
2	Manifold, Bypass	1407-3113-000	
3	Screw, M3x8 PT PAN PH SST	0142-4254-106	(2)
4**	O-ring, 59.92 ID 66.98 OD 3.53 W SIL 50 DURO	1407-3142-000	
5	Cap, Manifold	1407-3130-000	
6	Lever, Switch Actuator	1407-3116-000	
7	Spring, Torsion Switch Actuator Lever	1407-3117-000	
8*	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
9	Lever, Canister Latch	1407-3115-000	
10	Seal, Drain	1407-3121-000	
11**	O-ring, 37.69 ID 44.75 OD 3.53 W SIL 50 DURO	1407-3129-000	
12**	O-ring, 50.39 ID 57.45 OD 3.53 W SIL 50 DURO	1407-3143-000	
13**	O-ring, OD30 ID 22 4W SIL 40 DURO	1407-3104-000	(2)
14***	Valve, Housing Assembly Bypass	1407-3126-000	
15	Screw, Thumb M4 Shoulder 7.5 X 7	1407-3410-000	
16	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
17	Cradle Canister	1407-3118-000	
18	Screw, M4x10 CSK SKT HD SST TYPE 316	0140-6226-119	(2)
19**	Spacer, Shoulder 6.8 DIA x4.1 L	1407-3120-000	(2)
20	Support, Cradle Pivot	1407-3119-000	
21	Screw, M4x8 Sems BT SKT HD SST 316	0144-2436-108	(3)

* Apply Loctite 242.

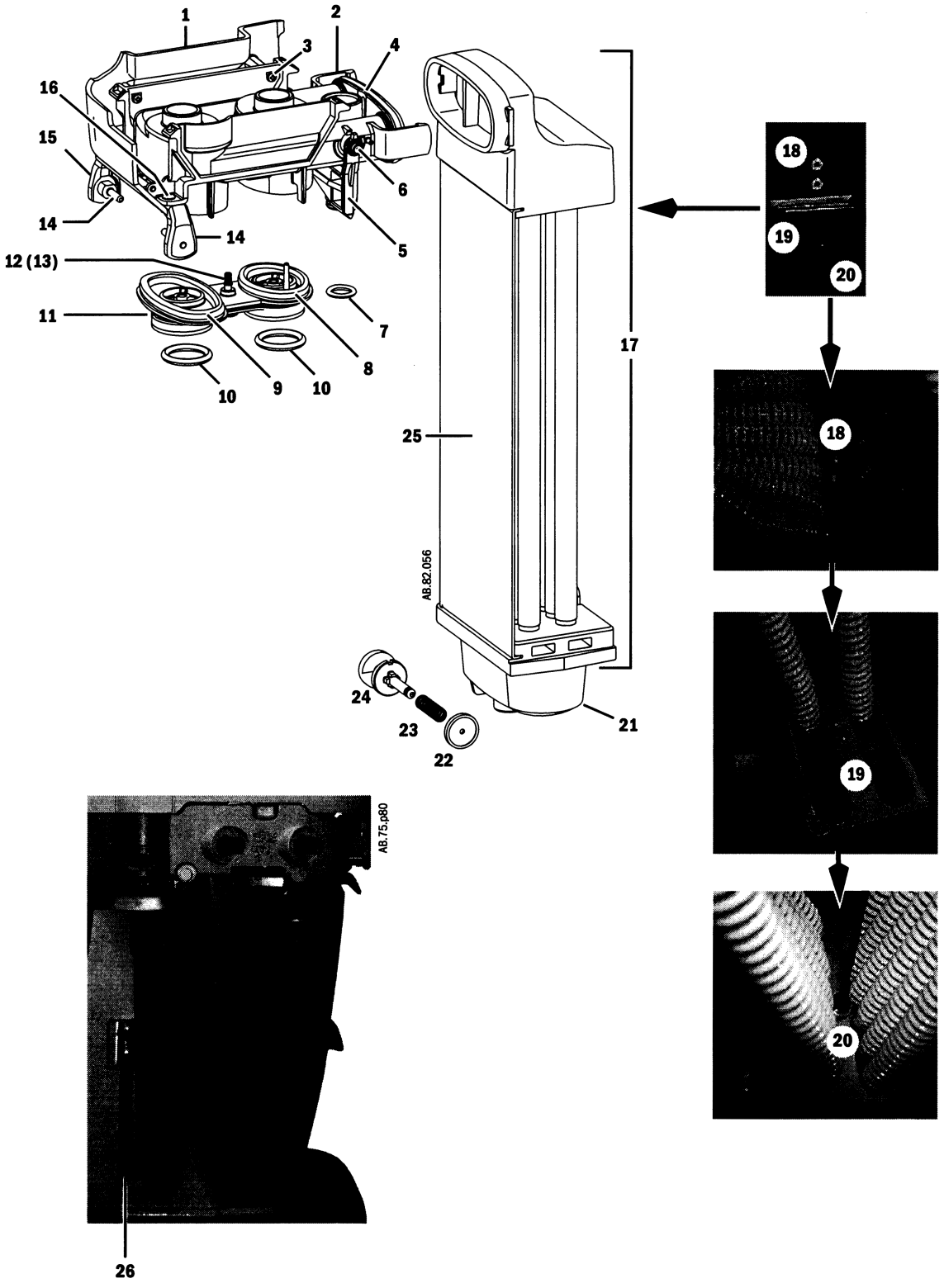
** Lubricate sparingly with Krytox.

*** Rubber valve seats can not be removed from assembly (**Item 14**).

10.21.11 Condenser

Item	Description	Stock Number	Qty
	Condenser assembly (includes all Items)	1407-7026-000	
	Condenser module (Items 1 through 16)	1407-7025-000	
	Condenser (Items 17 through 26)	1407-7024-000	
1	Cover, Bypass Manifold	1407-3123-000	
2	Manifold, Condenser	1407-3114-000	
3	Screw, PT PAN PH M3X8 SST	0142-4254-106	(2)
4**	O-ring, 63.09 ID 70.15 OD	1407-3142-000	
5	Lever, Canister Latch	1407-3115-000	
6*	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
7	O-ring, 12.37 ID 17.6 OD	1006-3968-000	
8**	O-ring, 37.69 ID 44.75 OD	1407-3129-000	
9**	O-ring, 50.39 ID 57.45 OD	1407-3143-000	
10**	O-ring, 22 ID 30 OD	1407-3104-000	(2)
11	Cap, Valve Housing	1407-3125-000	
12	Screw, Thumb M4 Shoulder 7.5 X 7	1407-3410-000	
13	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
14*	Pin, Condenser Manifold	1407-3131-000	(2)
15	Support, Cradle Pivot	1407-3119-000	
16	Screw, M4x8 Sems BT SKT HD	0144-2436-108	(3)
17	Tube Assembly	1407-3133-000-S	
18	Washer (part of Item 17)	----	(2)
19	Fork (part of Item 17)	----	
20	Screw, M5.28x20 (part of Item 17)	----	
21	Reservoir, Condenser	1407-3137-000	
22	Seal, Condenser Reservoir	1407-3136-000	
23	Spring, Compression Drain Button	1407-3135-000	
24	Button, Drain	1407-3134-000	
25	Cover, Condenser	1407-3138-000	
26	Guard	1407-3145-000	

* Apply Loctite 242.
** Lubricate sparingly with Krytox.


1
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16
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12 (13)
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17
AB.82.056
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AB.75.p80
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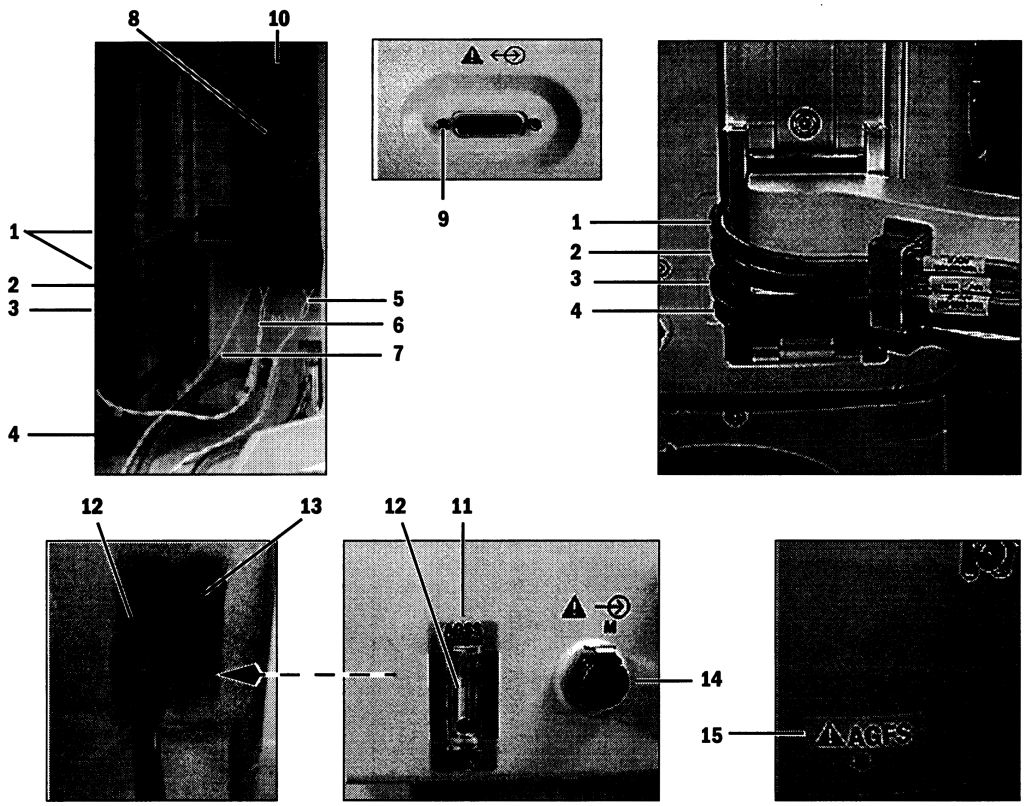
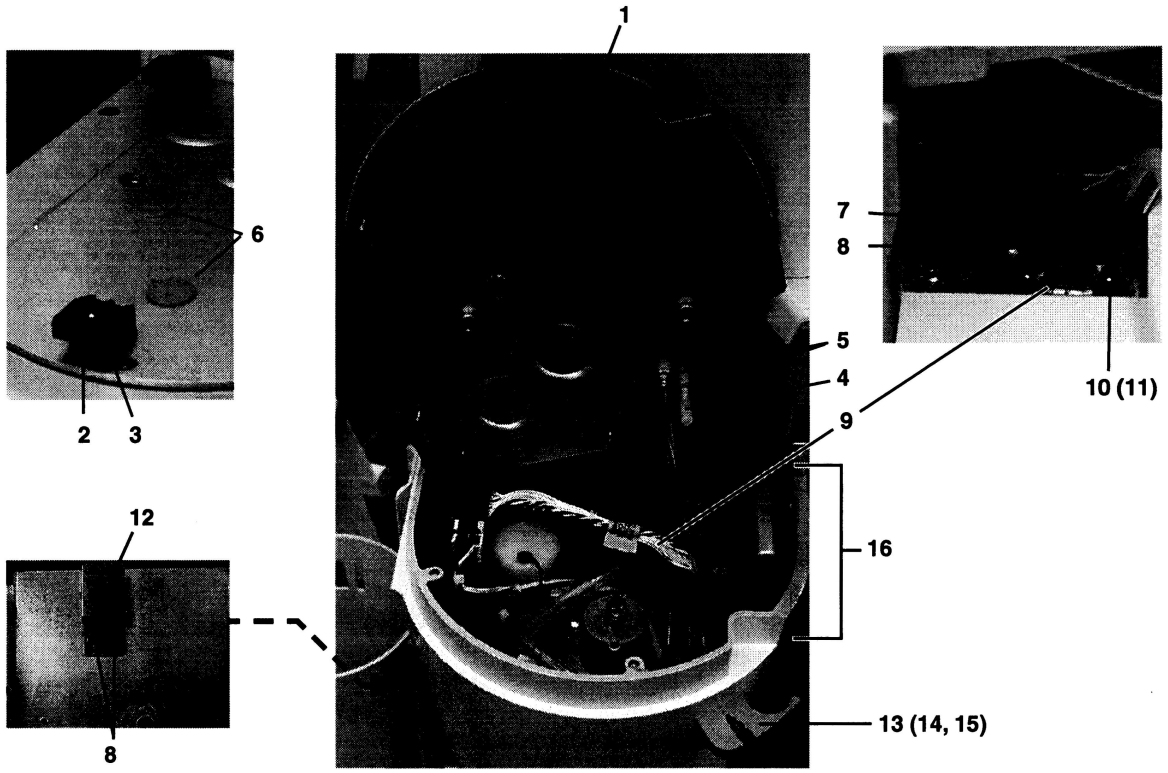
10.22 Display cables, serial board, AGSS flowtube, and sample return



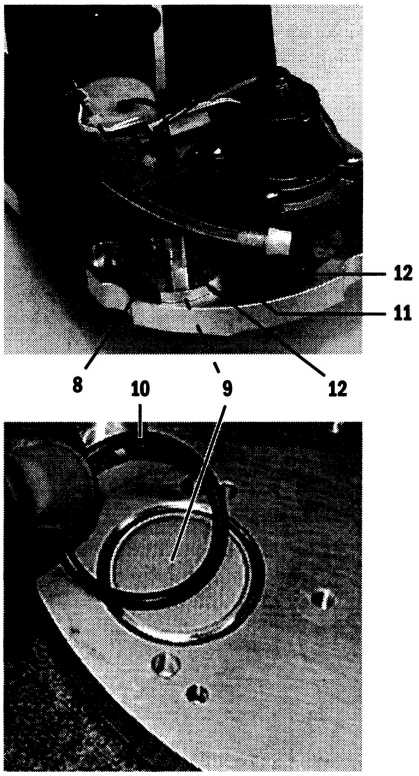
Item	Description	Stock Number
1	CABLE SER ISLN CONN BRD TO CTRL MOD 7100	1009-5691-000
2	CABLE MONITORING BOARD	1504-5604-000
3	CABLE PNEUMATIC ENGINE	M1100667
4	Cable, power	1009-5711-000
5	"Harness, Serial ISO to O2 flush SW"	1009-5567-000
6	"Harness, Serial ISO to O2 supply SW"	1009-5568-000
7	"Harness, Serial ISO to on/ standby SW"	1009-5566-000
8	Serial Isolation Board	1009-5500-000
9	Standoff	1202-3092-000
	Lockwasher	0144-1104-331
10	Screw, thread forming	1009-3400-000
11	Label, flow indicator AGSS	1406-3527-000
	Label, flow indicator AGFS (for German variant)	1009-3301-000
	Label, blank (for machines without flow indicator)	1009-3241-000
12	Flowtube, AGSS	1406-3560-000
13	Spring, AGSS flowtube	M1093853
14	Coupling, Colder (Kit includes mounting nut)	1009-8321-000
	Label set, blank (for machines without scavenging)	1009-3351-000
15	Label, AGFS (for German variant)	1009-3300-000

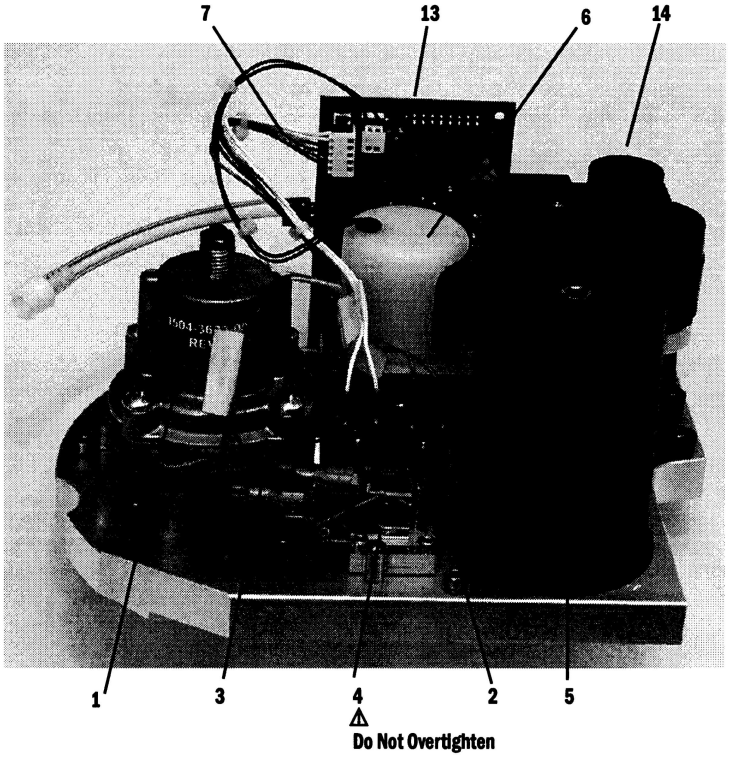
10.23 Vent Engine Housing



Item	Description	Stock Number	Qty
1	Vent Engine Cover Plate Assy	1407-7009-000	
2	TAB GUIDE BELLOWS BASE	1407-3313-000	(2)
3	SCR M3X16 POSI DR PAN HD A4 SST	1504-3003-000	(2)
4	Cap, Plug	1406-3524-000	
5	FITTING PNL MOUNT 3.18 HOSE BARB UNION	1504-3014-000	(2)
6	PLUG HOLE 15.9 DIA NYLON MICRO PLASTICS	1006-1473-000	
7	PLATE CONN VENT	1407-3321-000	
8	SCR M4X8 POZI-DR DIN84 PAN SERRATED	1006-3178-000	(5)
9	HARN VENT ENG BRD TO COIN SLOT	1009-5545-000	
10	BLOCK LATCHING DSUB CONN	1504-3617-000	(2)
11	SCR 4-40 X 3/8 SKT BCG HD CAP	0144-2117-206	(2)
12	Bracket, scavenging guard in machines without scavenging	1407-3922-000	
13	CLIP-SUCTION BAG HOSE	1407-3327-000	
14	SCR M5 X 16 PAN PH HD SST	9211-8350-163	(2)
15	Lockwasher	0144-1118-220	(2)
16	Vent Engine	Refer to section 10.24	

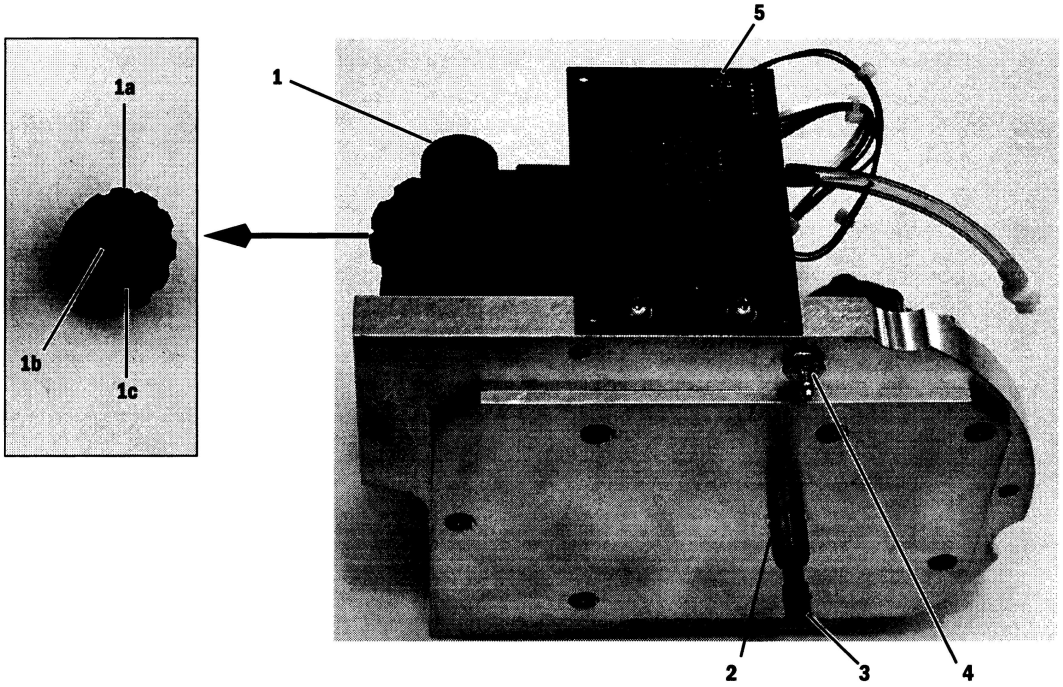
10.24 Vent Engine





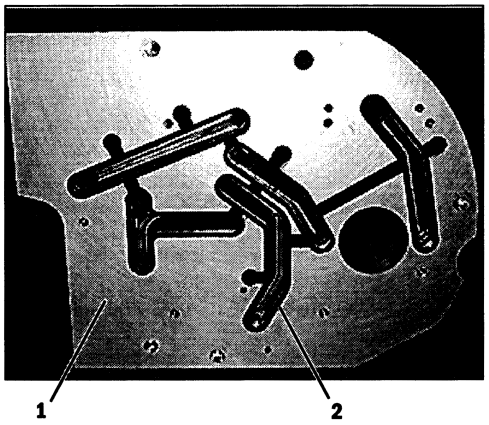
Item	Description	Stock Number
	Pneumatic Engine Assembly, Service-Aespire machine	1009-8000-000
1	Regulator O-ring, 9.25 ID x 12.8 OD (2)	1504-3623-000 1503-3056-000
2	PEEP Valve (blue dots)	1504-3610-000
3	PEEP Safety Valve (white dot)	1504-3608-000
4	Pressure Sense Switch O-ring, 3.63 ID x 8.87 OD	1504-3607-000 1006-4156-000
5	Reservoir, pneumatic engine O-ring, base, 56.87 ID x 60.43 OD O-ring, screw head, 0.219 ID x 0.344 OD	1504-3704-000 1504-3614-000 0210-0686-300
6	Inspiratory Flow Control Valve O-ring, 9.25 ID x 12.8 OD (2)	1504-3620-000 1503-3056-000
7	Harness, valve switches	1504-5700-000
8	Fitting, 8-mm Drive Gas	1504-3618-000
9	Filter, 2-micron (**Install course side DOWN**)	1504-3708-000
10	O-ring, 28.24 ID 33.48 OD	1504-3015-000
11	Retainer, filter	1504-3718-000
12	Screw, M4x20 SKT HD CAP Lockwasher, M4 internal	1503-3105-000 0144-1118-128
13	Vent Engine Board (not part of assembly)	Refer to 10.24.1
14	Interface Manifold	Refer to 10.24.1

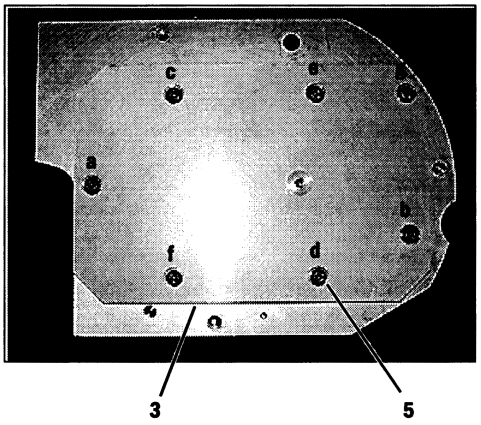
10.24.1 Vent Engine - under side



Item	Description	Stock Number
1	Interface Manifold, pneumatic engine (with free breathing valve and mechanical overpressure valve) O-ring, 12.37 ID x 17.6 OD (2)	1504-8505-000 1006-3615-000
	a - Seat, free breathing valve	1503-3204-000
*	b - Valve, flapper	0211-1454-100
	c - O-ring	1503-3208-000
2	Fitting, 6.35-mm (1/4-inch)	1504-3621-000
3	Plug, 6.35-mm (1/4-inch)	1503-3245-000
4	Fitting, barbed	1504-3014-000
5	Vent Engine Board (not part of assembly)	1009-8001-000
* If necessary, clean with alcohol before installing new; trim off flush with outside surface of seat (refer to removed flapper).		

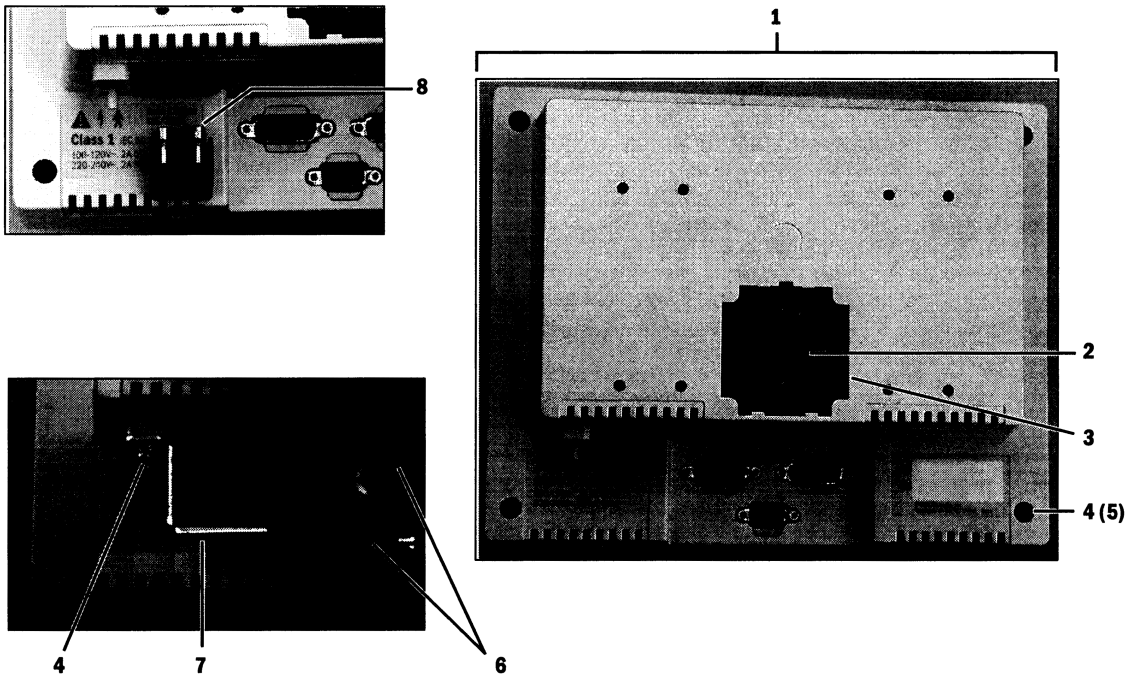
10.24.2 Manifold plate





Item	Description	Stock Number
1	Manifold	1504-3715-000
2*	Gasket, manifold	1504-3717-000
3	Plate, manifold	1504-3716-000
4**	Screw, M4x12 Lockwasher, M4 internal	1102-3006-000 0144-1118-128
5**	Screw, M4x8 Pozidriv PAN	1006-3178-000
* Install gasket into manifold. Check to see that it is properly positioned. ** Carefully install plate onto manifold making sure not to disturb the gasket. First, start all screws. Then, torque to 1.7 N-m (15 lb-in) using sequence shown.		

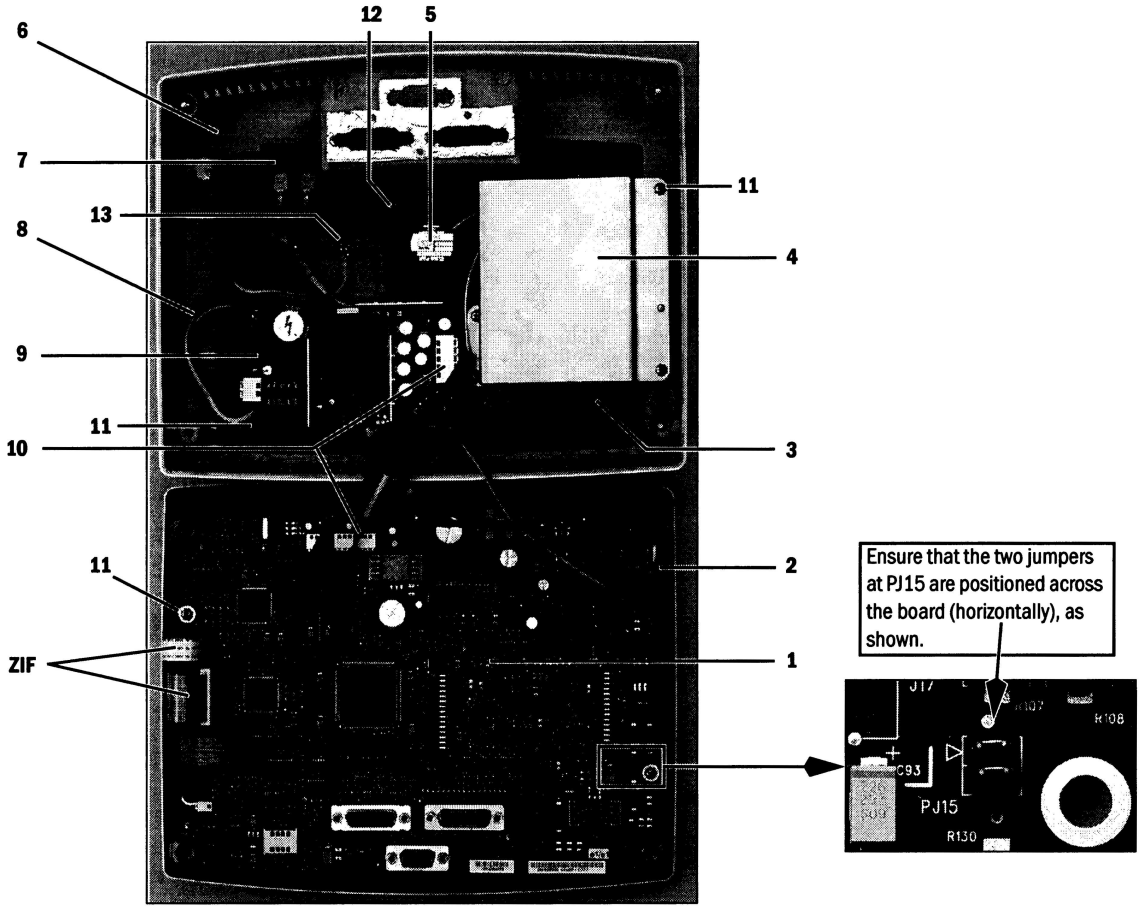
10.25 Display Assembly



Item	Description	Stock Number
1*	Control Module (original) Control Module (Color)	1504-8500-000 M1106333
2	Filter, fan	1504-3519-000
3	Retainer, fan filter	1504-3518-000
4	Screw, M4x12 relieved body	1504-3001-000
5	Lockwasher, M4 external	9213-0540-003
6	Cables	Refer to section 10.29
7	Retainer, power cord	1504-3503-000
8	Fuse, 5x20mm 2A Time DLY	1009-5778-000

* Also order appropriate revision Software Memory Stick.
- Refer to Section 10.1 for Stock Number.
- Refer to Section 8.2 for instructions regarding a replaced Control Board or Control Module

10.25.1 Display components (Color)



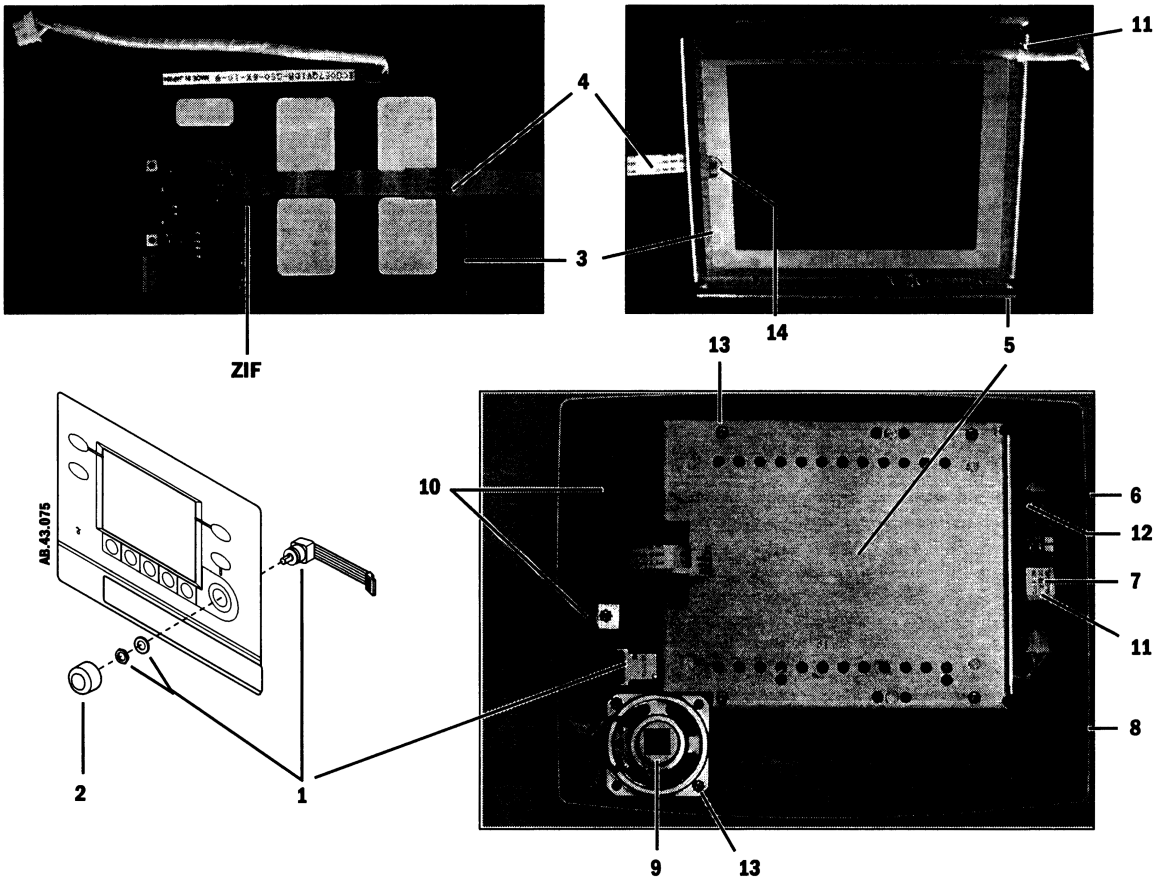
Item	Description	Stock Number
1*	Control Board, color	M1074336-S
2	Ground wire	M1081616-S
3	Battery, 6V 4R5HA sealed lead acid	M1081511-S
4	Plate, battery retainer	M1100720
5	Fan, 5 VDC	M1081513-S
6	Enclosure, rear	M1100721
7	AC Inlet, double pole snap-in	1504-3515-000
8	Harness, power AC	M1081518-S
9	Power Supply, Universal 40W	1609-3040-000
10	Harness, power DC	M1081520-S
11	Screw, M3x6	0140-6219-128
12	Screw, M3x16	M1091502-S
13	Screw, M4x6	M1096258-S

* Also order appropriate revision Software Memory Stick.

- Refer to Section 10.1 for Stock Number.
- Refer to Section 8.2 for instructions regarding a replaced Control Board or Control Module

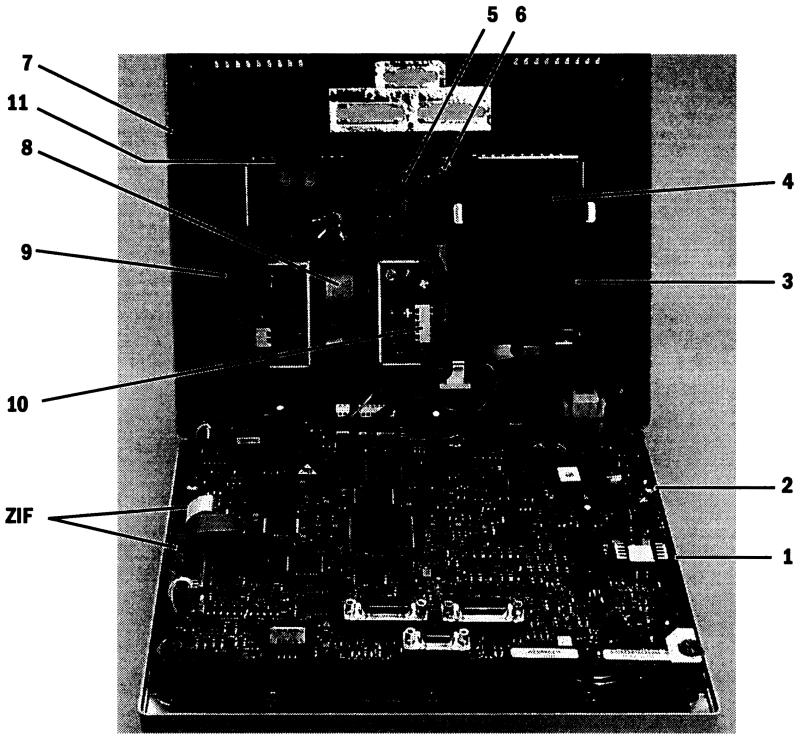
ZIF: zero insertion-force connector; pull tabs toward cable to release.

10.25.2 Display Keyboard and LCD assembly (Color)



Item	Description	Stock Number
1	Rotary Encoder, switch	1503-3012-000
2	Knob, soft touch	M1081590-S
3	Display, LCD 320x240 (includes backlight)	M1115067
4	Display Cable, flat flex	M1081524-S
5	Bracket, display mount	M1100723
6	Cable, backlight inverter	M1082243-S
7	Inverter, with protective foil	M1100722
8	Gasket, EMC 2.2 OD hollow RND (per enclosure)	M1120773-S
9	Speaker, with harness	M1081516-S
10	Enclosure, front cover assembly with keyboard	M1100719
11	Cable tie	M1096281-S
12	Screw, M2x4	M1081612-S
13	Screw, M3x6	0140-6219-128
14	Screw, M3x12	M1096259-S
ZIF: zero insertion-force connector; pull tabs toward cable to release.		

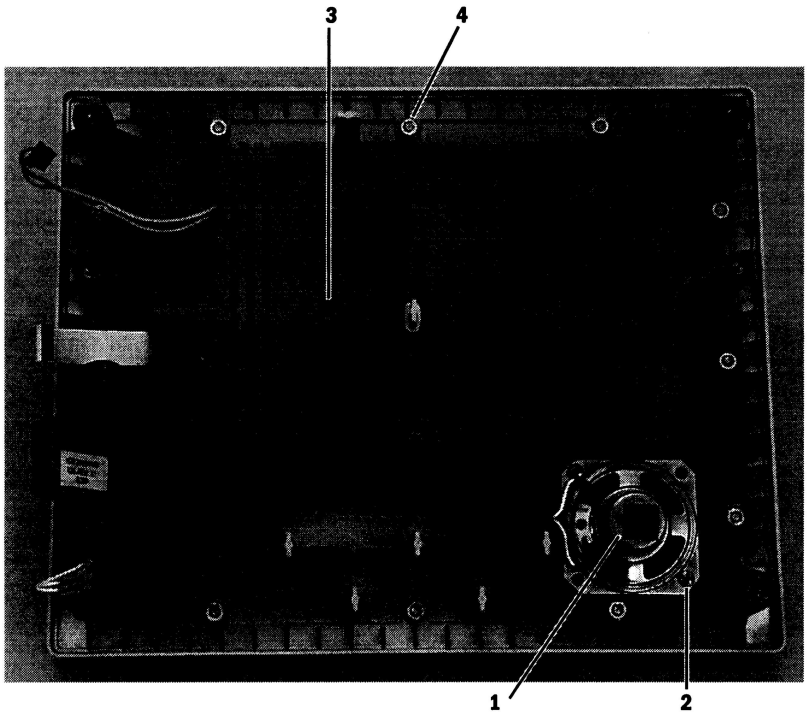
10.25.3 Display components (non-color)



Item	Description	Stock Number
1*	Control Board	1504-8507-000
2	Screw, M4x8 SEMS	0140-6226-113
3	Battery, 6 V 4 AH sealed lead acid	1504-3505-000
4	Strap, battery retainer	1504-3509-000
5	Fan, 5 VDC	1504-3516-000
6	Nut, M3 KEPS	0144-3717-302
7	Enclosure, rear	1504-8506-000
8	Power Supply, Universal 40W	1609-3040-000
9	Harness, power AC	1504-5613-000
10	Harness, power DC	1504-5614-000
11	AC Inlet, double pole snap-in	1504-3515-000

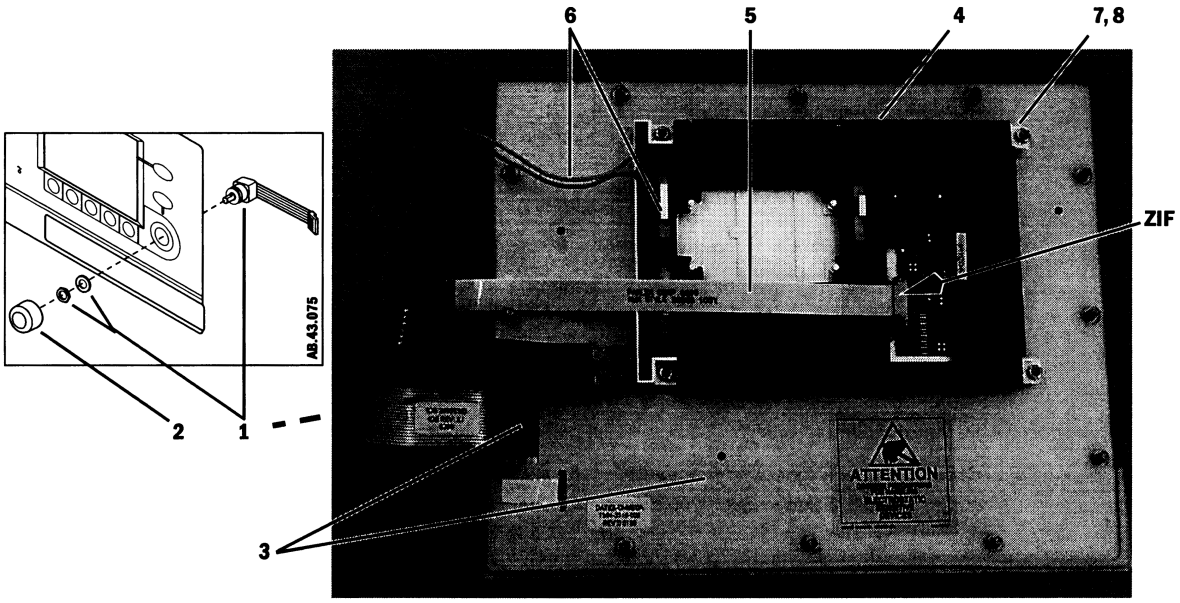
* Also order appropriate revision Software Memory Stick.
- Refer to Section 10.1 for Stock Number.
- Refer to Section 8.2 for instructions regarding a replaced Control Board or Control Module

10.25.4 Display, front cover assembly (non-color)



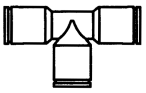
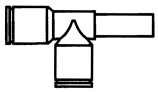
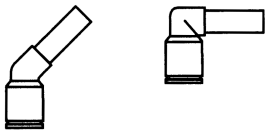
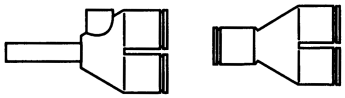
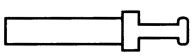
Item	Description	Stock Number
1	Speaker, with harness	1504-3513-000
2	Screw, M3x6	0140-6219-128
3	Enclosure, front	1504-3500-000
4	Nut, M4 KEPS	0144-3717-314

10.25.5 Display Keyboard and LCD assembly (non-color)



Item	Description	Stock Number
1	Rotary Encoder, switch	1503-3012-000
2	Knob, soft touch	M1081590
3	Keyboard, front panel	1504-3534-000
4	Display, LCD 320x240 (includes backlight)	1504-3507-000
5	Display Cable, flat flex	1504-5602-000
6	Backlight (Refer to Section7.2.5, *"To replace the backlight."*	1504-8509-000
7	Spacer	1504-3525-000
8	Nut, M3 KEPS	0144-3717-302
***ZIF:** zero insertion-force connector; pull tabs toward cable to release.		

10.26 Legris quick-release fittings

	Item	Description	Stock Number
	1	**Tees – (tube/tube/tube)**	
		4 mm (N_2O)	1202-3653-000
		6 mm (O_2)	1006-3544-000
		8 mm (Air)	1006-3545-000
		8 mm/6 mm/8 mm (SCGO pilot)	1009-3297-000
		3/16 inch (CO_2 and Heliox)	0213-4727-300
	2	**Tees – (tube/tube/standpipe)**	
		6 mm (O_2)	1006-3862-000
		8 mm (Air - Drive gas)	1009-3370-000
	3	**Elbow – (tube/standpipe)**	
		4 mm (N_2O)	1006-3533-000
		6 mm (O_2)	1006-3534-000
		8 mm (Air)	1006-3535-000
		1/4 inch (mixed gas)	1006-3737-000
		1/4 inch (45° - mixed gas)	1009-3368-000
	4	**Elbow – (tube/tube)**	
		1/4 inch (mixed gas)	1202-3804-000
		4 mm (N_2O)	1009-3040-000
		6 mm (O_2)	1009-3041=000
	5	**Y**	
		6 mm (O_2)	1009-3043-000
		8 mm (Air)	1009-3044-000
		8 mm Y with tailpiece	1009-3360-000
		1/4 inch (mixed gas)	1006-3065-000
	6	**Plug**	
		4 mm (N_2O)	1006-3530-000
		6 mm (O_2)	1006-3531-000
		8 mm (Air)	1006-3532-000
		3/16 inch (CO_2 and Heliox)	1006-3835-000

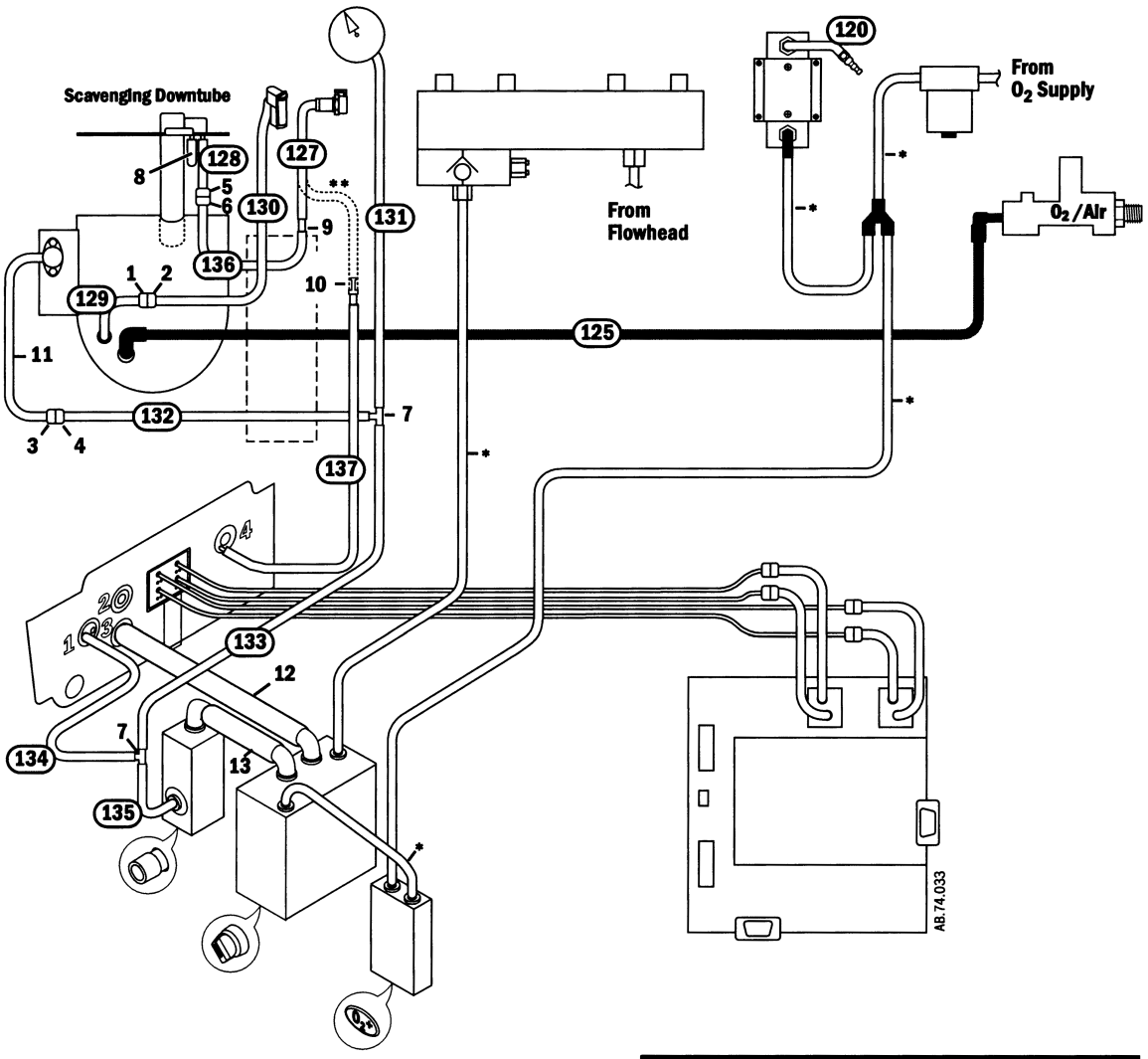
Note: Not every fitting is used in all machines.

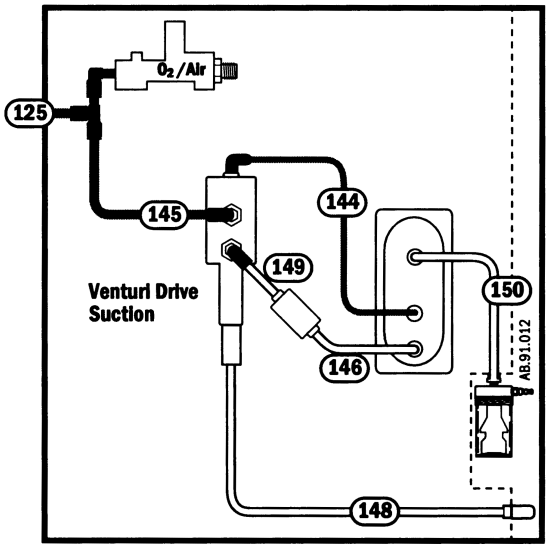
10.27 Vent Drive and low-pressure tubing

Item	Description		Length — Size	Stock Number
1	Coupler, female - black			1503-3128-000
2	Coupler, male - black			1503-3237-000
3	Coupler, female - white			1503-3119-000
4	Coupler, male - white			1503-3236-000
5	Coupler, female - yellow			1503-3132-000
6	Coupler, male - yellow			1407-3330-000
7	Tee (male barb)			1009-3011-000
8	Cap, plug			1406-3524-000
9	Fitting, coupler barb ends			1009-3077-000
10	Plug, 4-mm			1006-3530-000
11	Tubing, low-pressure		151 mm - 1/4 inch	1605-1001-000
12	Tubing (silicone)		72 mm - 3/8 inch	1009-3164-000
13	Tubing (silicone)		42 mm - 3/8 inch	1009-3164-000
	Tube Markings (factory build only)		**Length — Size**	
125	VENT DRIVE	(black)	900 mm - 8 mm	1009-3296-000
120	Aux O2 OUT	(low-pressure)	250 mm - 1/4 inch	1605-1001-000
127	RGM return	(low-pressure)	750 mm - 1/4 inch	1605-1001-000
128	unmarked	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
129	unmarked	(low-pressure)	151 mm - 1/4 inch	1605-1001-000
130	AGSS flowtube	(low-pressure)	750 mm - 1/4 inch	1605-1001-000
131	PAW	(low-pressure)	600 mm - 1/4 inch	1605-1001-000
132	PAW	(low-pressure)	260 mm - 1/4 inch	1605-1001-000
133	PAW	(low-pressure)	330 mm - 1/4 inch	1605-1001-000
134	unmarked	(low-pressure)	25 mm - 1/4 inch	1605-1001-000
135	unmarked	(low-pressure)	50 mm - 1/4 inch	1605-1001-000
136	RGM to Scavenge	(low-pressure)	200 mm - 1/4 inch	1605-1001-000
137	RGM to Circuit	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
144	Venturi Pilot	(black)	330 mm - 4 mm	1009-3363-000
145	Venturi Drive	(black)	300 mm - 8 mm	1009-3296-000
146	unmarked	Tygon	260 mm - 1/2 inch	6700-0005-300
148	unmarked	Tygon	465 mm - 1/2 inch	6700-0005-300
149	unmarked		40 mm - 8 mm	1001-3063-000
150	unmarked	Tygon	180 mm - 1/2 inch	6700-0005-300

*Refer to section 10.28

** Sample gas return is directed to the scavenging system as a factory default. A qualified service representative can reroute the sample gas back to the breathing system (refer to Section 9.11).


Scavenging Downtube
From Flowhead
From O_2 Supply
O_2/Air
AB.74.033


O_2/Air
Venturi Drive Suction
AB.91.012

10.28 Tubing for use with Legris fittings

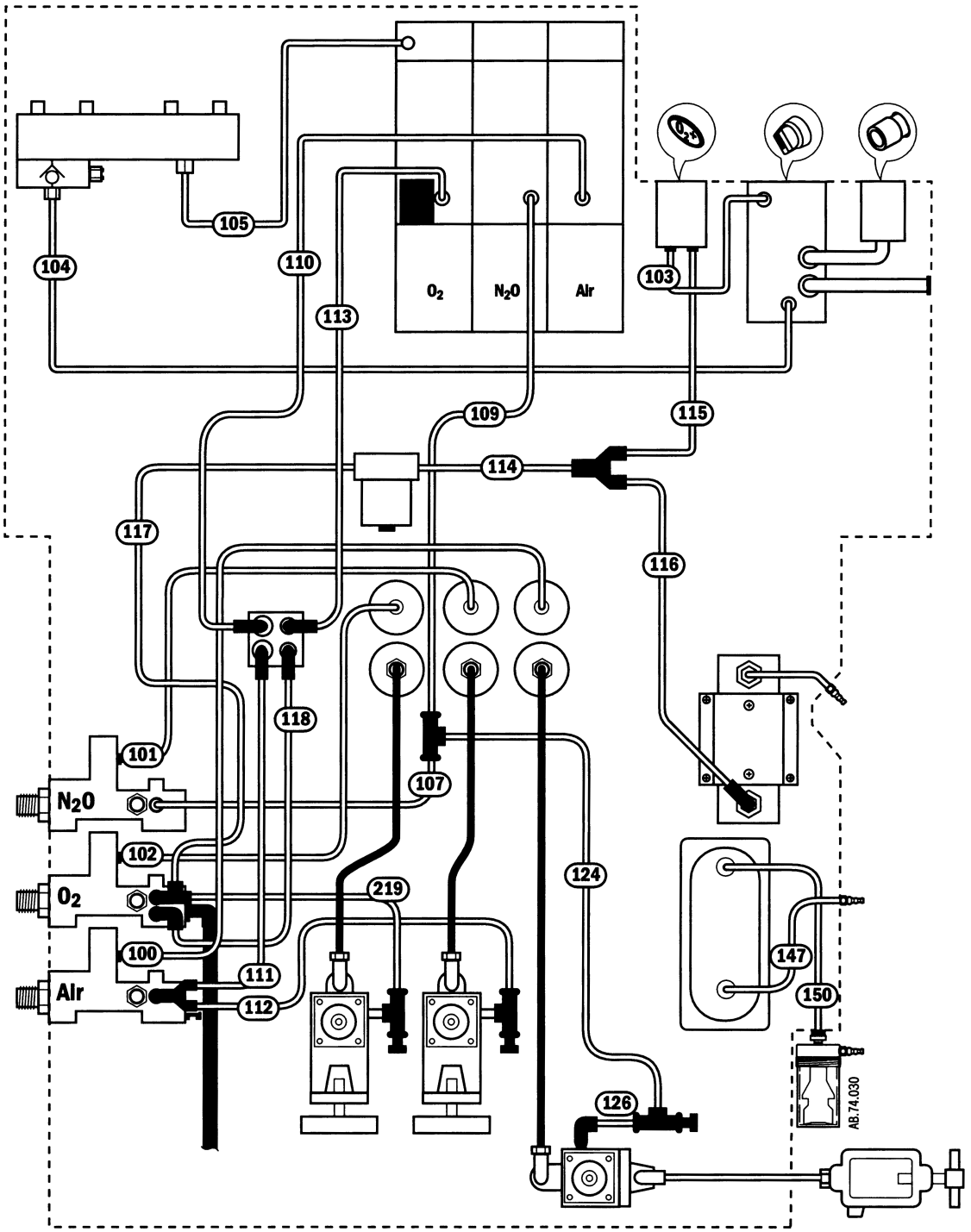
Except for the Tygon tubing (Items 147 and 150), this tubing is a flexible, Nylon-type tubing for use with quick-release fittings.

Item	Description	Length – Size	Stock Number
106*	N20 PLINE - N20 FLWMOD	1200 mm - 4 mm	1001-3060-000
107*	N20 PLINE - N20 CYL	430 mm - 4 mm	1001-3060-000
108**	UNMARKED	40 mm - 4 mm	1001-3060-000
109*	N20 CYL - N20 FLWMOD	800 mm - 4 mm	1001-3060-000
124**	Unmarked	250 mm - 4 mm	1001-3060-000
126	Unmarked	50 mm - 4 mm	1001-3060-000
113	SW4-02 FLWMOD	1350 mm - 6 mm	1001-3062-000
114	REGULATED 02	400 mm - 6 mm	1001-3062-000
115	REGULATED 02	600 mm - 6 mm	1001-3062-000
116	AUX 02	250 mm - 6 mm	1001-3062-000
117	02 PLINE - REG IN	330 mm - 6 mm	1001-3062-000
118	02 PLINE - 02 SW3	270 mm - 6 mm	1001-3062-000
123***	unmarked	175 mm - 6 mm	1001-3062-000
219	02 CYL - 02 PLINE	215 mm - 6 mm	1001-3062-000
111	AIR PLINE - AIR SW3	460 mm - 8 mm	1001-3063-000
110	SW4-AIR FLWMOD	1350 mm - 8 mm	1001-3063-000
112	AIR CYL- AIR PLINE	270 mm - 8 mm	1001-3063-000
100	AIR PLINE - AIR GAGE	470 mm - 1/8 inch	1006-3718-000
101	N20 PLINE - N20 GAGE	470 mm - 1/8 inch	1006-3718-000
102	02 PLINE - 02 GAGE	470 mm - 1/8 inch	1006-3718-000
104	VAP OUT- ACGO	840 mm - 1/4 inch	1001-3064-000
105	FLWMOD-VAP IN	840 mm - 1/4 inch	1001-3064-000
103	FLUSH VLV-ACGO	280 mm - 1/4 inch	1001-3064-000
147	unmarked (Tygon)	290 mm - 1/2 inch	6700-0005-300
150	unmarked (Tygon)	180 mm - 1/2 inch	6700-0005-300

* With no N_2O cylinder supply, Items 107 and 109 are replaced with Item 106.

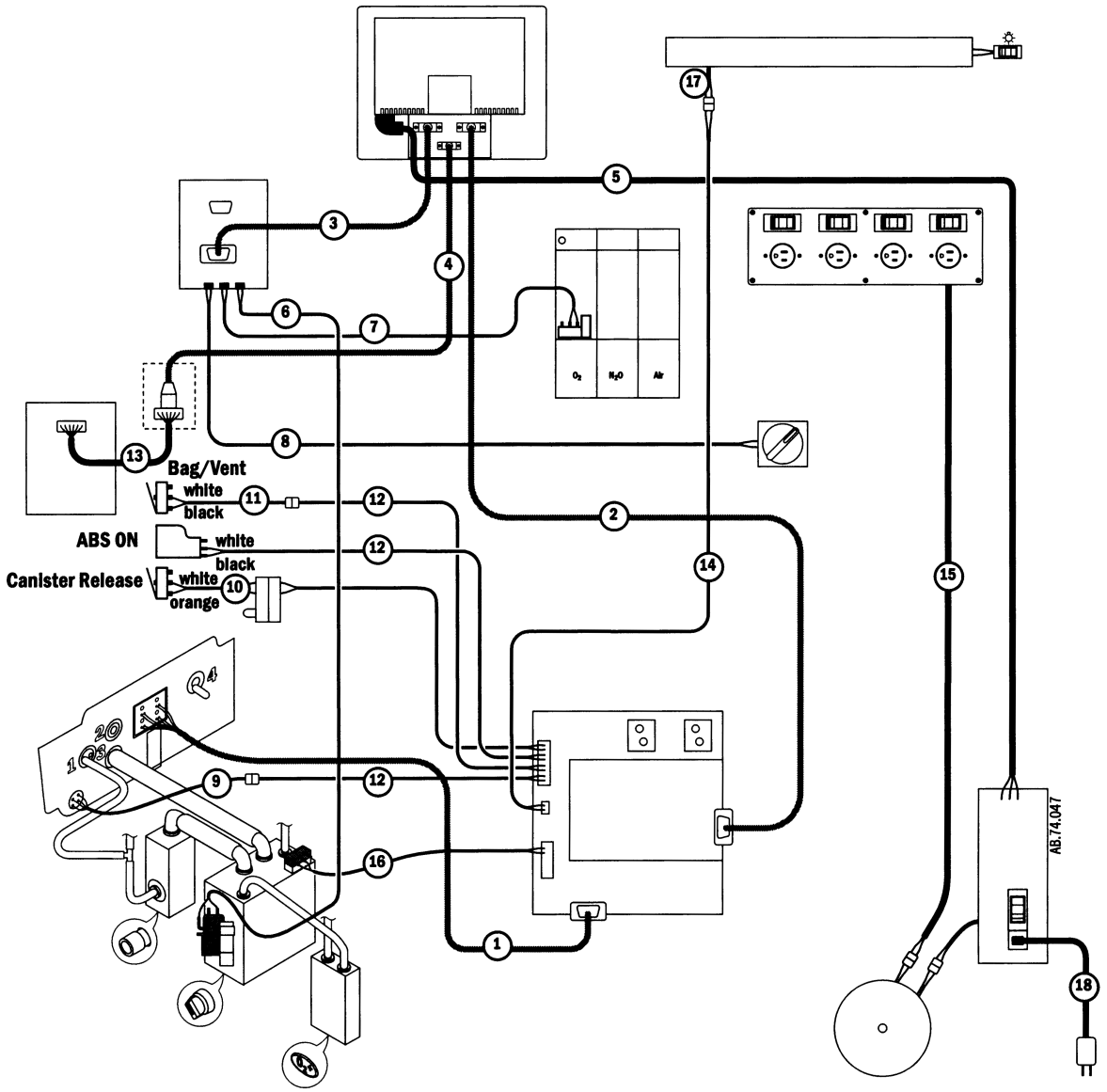
** With an inboard N_2O cylinder supply, Items 124 is replaced with Item 108.

*** With two inboard O_2 cylinder supplies, Item 123 connects the second O_2 cylinder supply to the first O_2 cylinder supply.


105
104
110
113
O_2
N_2O
Air
103
109
115
114
117
116
118
101
107
N_2O
102
O_2
219
124
100
Air
111
112
147
150
126
AB.74.030

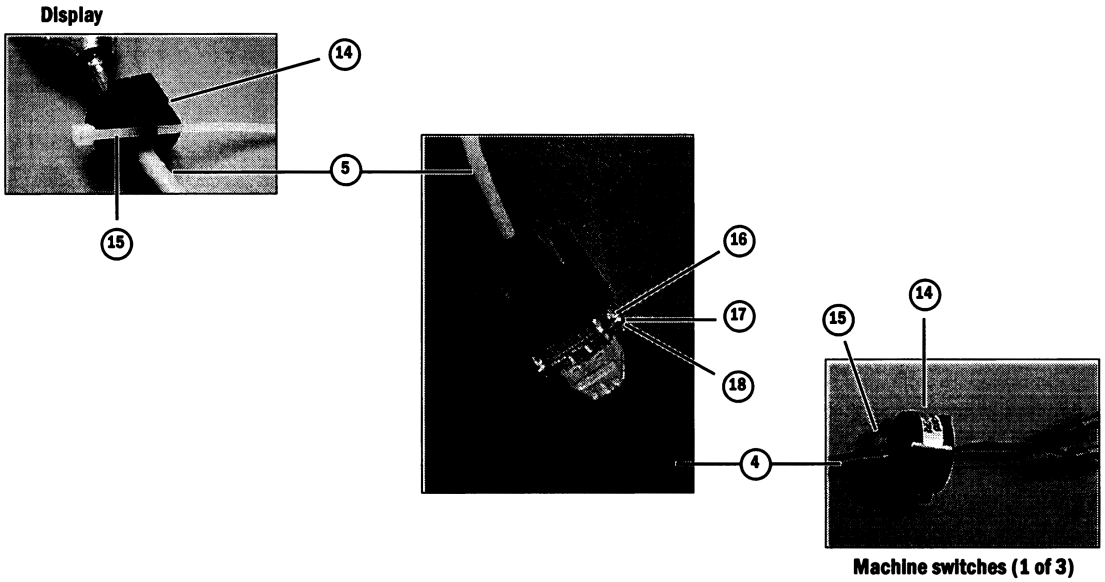
10.29 Cables and harnesses

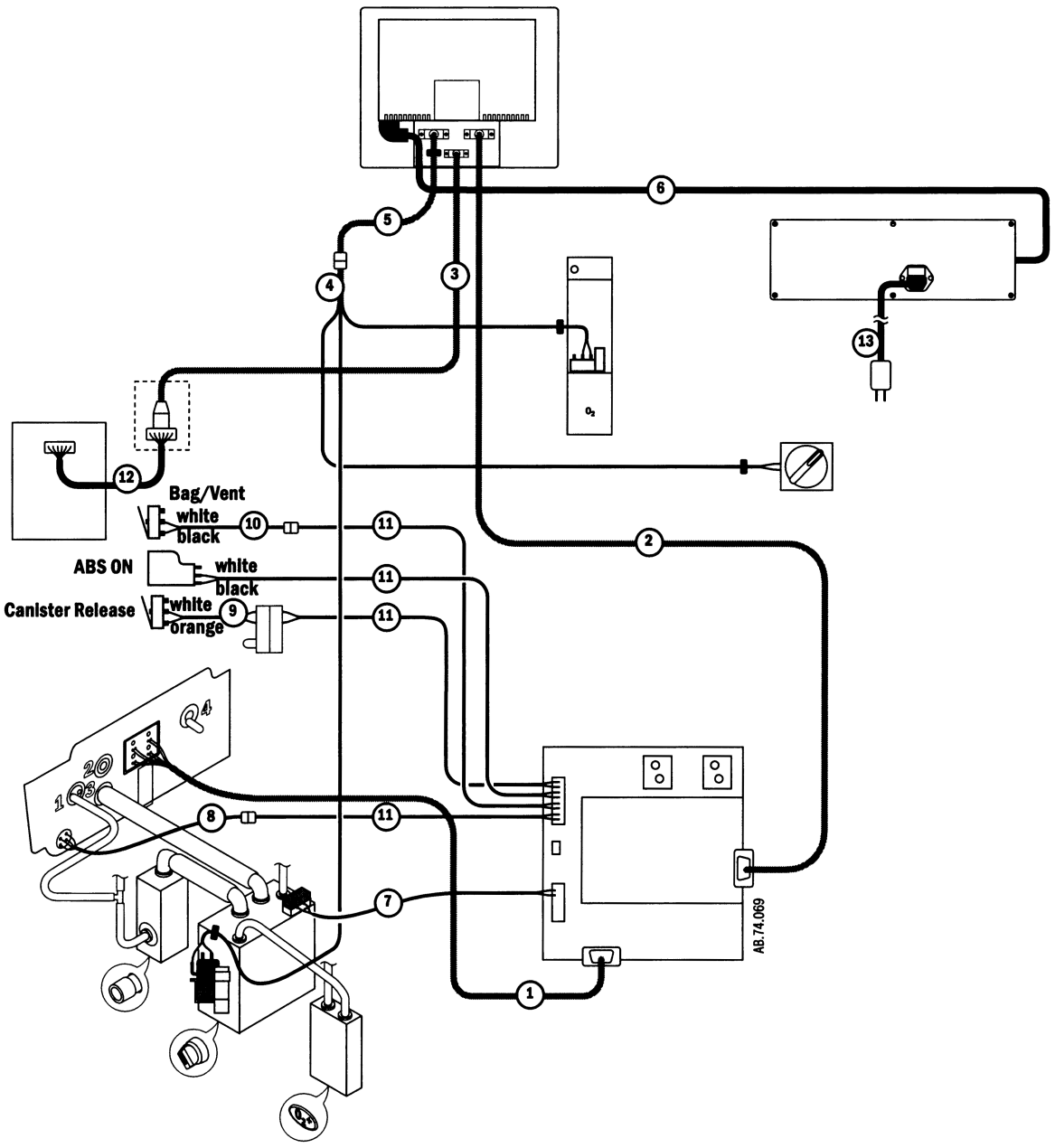
Item	Description	Stock Number
1	Harness, Vent Monitoring board to ABS flow sensors (includes tubing)	1009-8165-000
2	Cable, Vent Monitoring board	1504-5604-000
3	Cable, Serial Isolation	1009-5691-000
4	Cable, Pneumatic Vent Engine	M1100667
5	Cable, power	1009-5711-000
6	Harness, Serial ISO to O2 flush SW	1009-5567-000
7	Harness, Serial ISO to O2 supply SW	1009-5568-000
8	Harness, Serial ISO to on/ standby SW	1009-5566-000
9	Harness, O2 CELL TO FTLR BRD HARN	1009-5586-000
10	Harness, Canister Release switch (CO_2 Bypass)	1407-3144-000
11	Harness, BAG TO VENT SW TO HARN FTLR BRD	1009-5585-000
12	Harness, FLTR BRD TO B/S O2 SNSR AND SW	1009-5531-000
13	Harness, VENT ENG BRD TO CONN PLATE	1009-5545-000
14	Harness, Vent Mon Brd to Task Light	1009-5533-000
15	Harness, to 100/120 V outlets Harness, to 220/240 V outlets	1009-5716-000 1009-5717-000
16	Harness, ACGO Switch	1009-5762-000
17	Harness, Task Light	1009-5584-000
18	Power Cord	Refer to section 10.12


17
5
3
4
6
7
8
13
Bag/Vent
white
black
11
12
ABS ON
white
black
12
Canister Release
white
orange
10
2
14
15
9
12
16
1
18
AB.74.047

10.30 Cables and harnesses (Aespire 100)

Item	Description	Stock Number
1	Harness, Vent Monitoring board to ABS flow sensors (includes tubing)	1009-8165-000
2	Cable, Vent Monitoring board	1504-5604-000
3	Cable, Pneumatic Vent Engine	M1100667
4	Cable, machine switches	1006-4528-000
5	Cable, display to machine switches cable	1504-5606-000
6	Cable, power to Control module	1009-5711-000
7	Harness, ACGO Switch	1009-5762-000
8	Harness, O_2 CELL TO FTLR BRD HARN	1009-5586-000
9	Harness, Canister Release switch (CO_2 Bypass)	1407-3144-000
10	Harness, BAG TO VENT SW TO HARN FTLR BRD	1009-5585-000
11	Harness, FLTR BRD TO B/S O_2 SNSR AND SW	1009-5531-000
12	Harness, VENT ENG BRD TO CONN PLATE	1009-5545-000
13	Power Cord, machine	Refer to section 10.12
14	Ferrite	1009-6059-000
15	Cable tie	0203-5915-300
16	Jack post	1202-3092-000
17	Lockwasher	0144-1104-331
18	Nut, 4-40	0144-3117-113




6
5
4
3
13
12
Bag/Vent
white
black
10
11
ABS ON
white
black
Canister Release
white
orange
9
2
8
7
1
AB.74.069

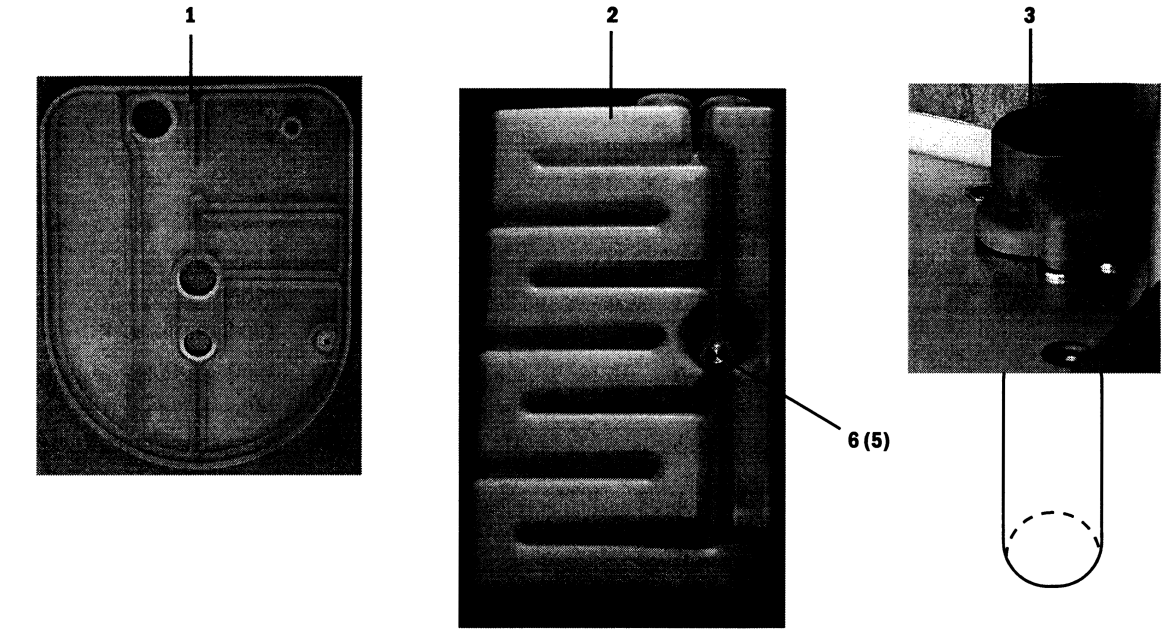
10.31 Anesthetic Gas Scavenging System – AGSS

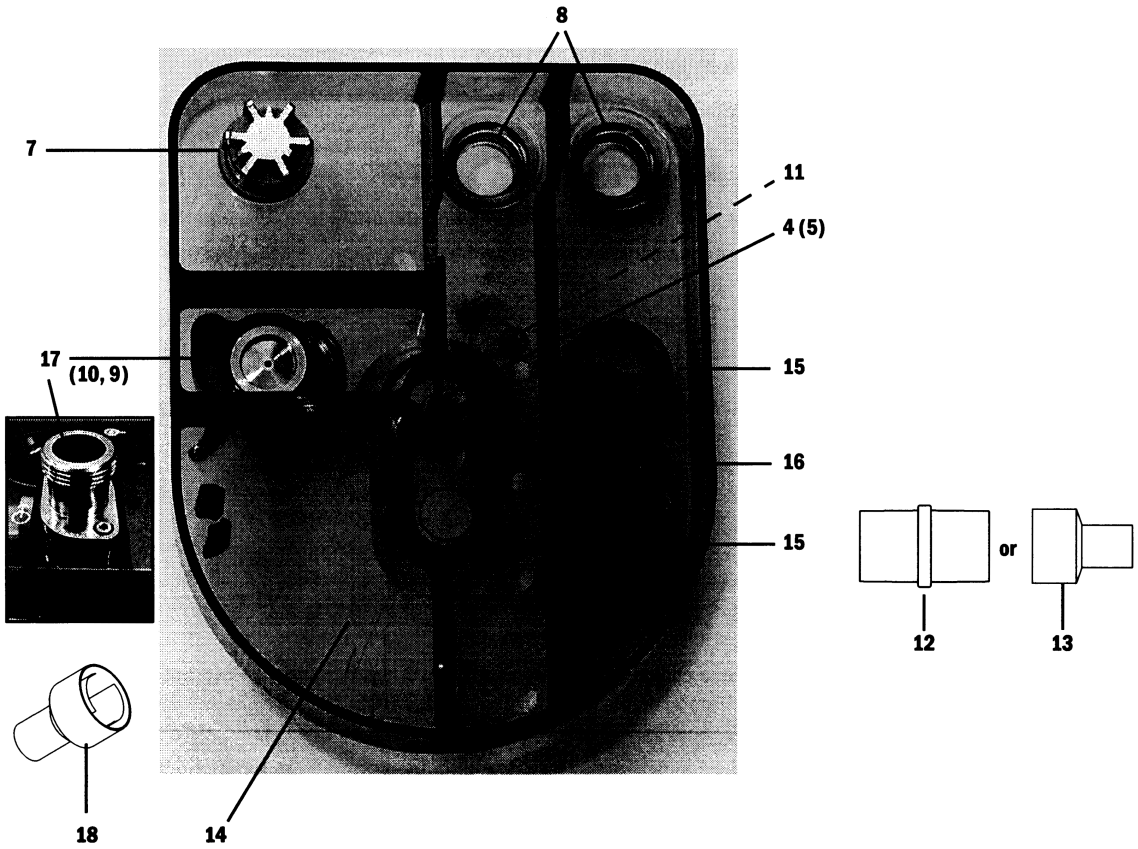
10.31.1 Passive AGSS

Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Passive AGSS Specific Parts			
14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	(2)
16	Screw, shoulder M3	1407-3915-000	
17	Connector, 30-mm ISO, Male	1406-3555-000	
18	Adapter, scavenging, 30-mm female to 19-mm male	1500-3376-000	(5 pack)

* Lubricate sparingly with Krytox


1
2
3
6 (5)

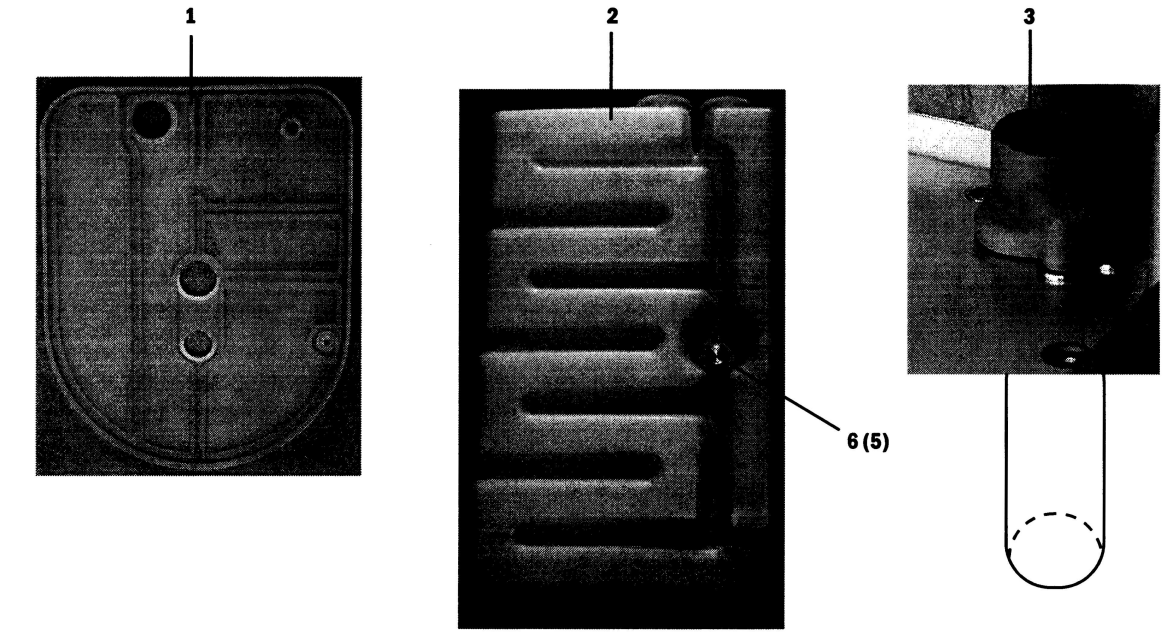

8
7
11
4 (5)
17
(10, 9)
15
16
15
or
12
13
18
14

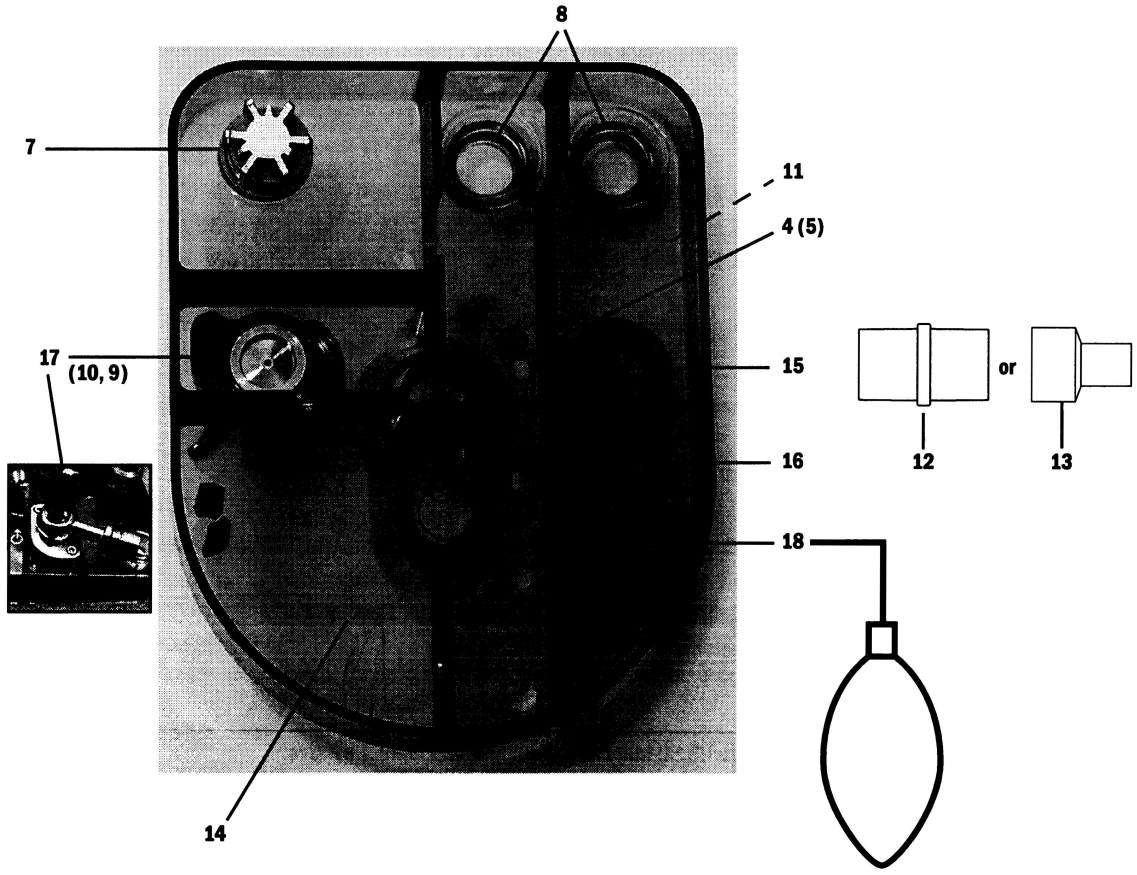
10.31.2 Adjustable AGSS

Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Adjustable AGSS Specific Parts			
14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	
16	Screw, shoulder M3	1407-3915-000	
17	Needle Valve Assembly (with DISS EVAC connector)	1407-3918-000	
18	Bag with 30 mm male connector	8004460	

* Lubricate sparingly with Krytox


1
2
3
6 (5)

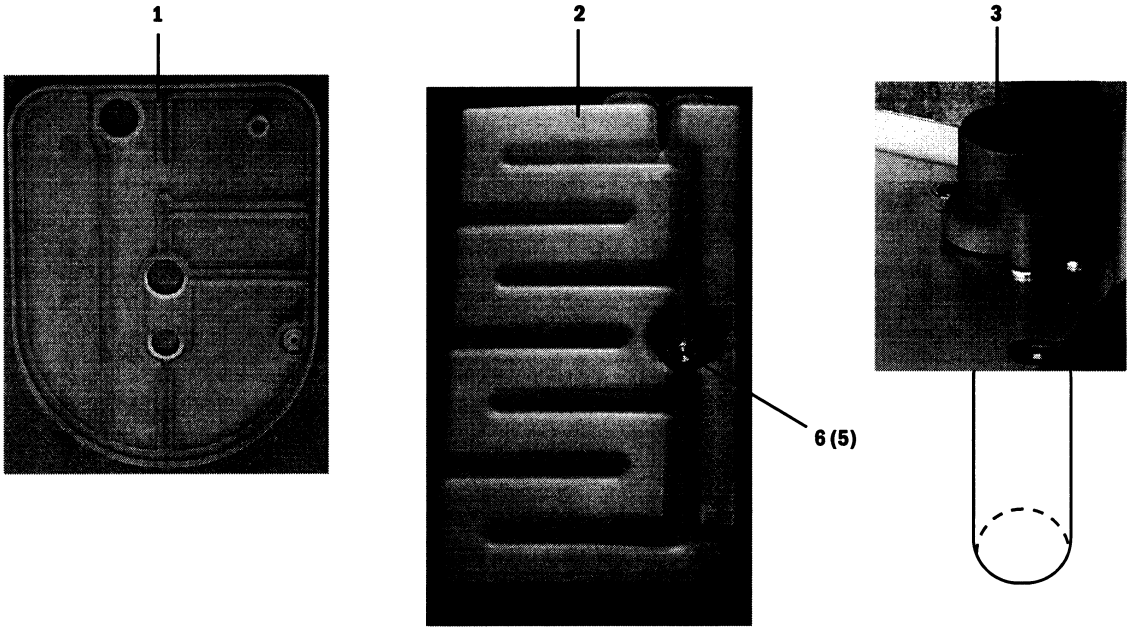

8
7
11
4 (5)
17
(10, 9)
15
16
18
or
12
13
14

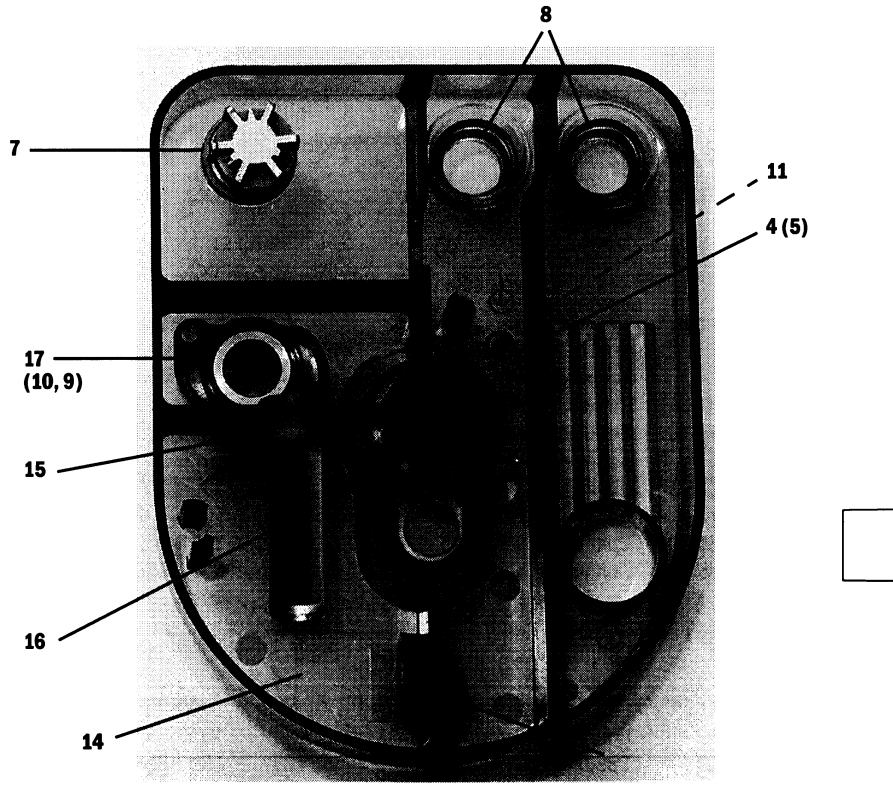
10.31.3 Active AGSS

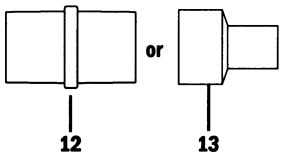
Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Active AGSS Specific Parts			
14	Receiver, with air brake	1407-3900-000	
15	Seal, for filter and orifice	1407-3902-000	(2)
16	Filter	1406-3521-000	
Active High Flow Specific Parts			
17a	Connector, high flow M30 thread	1406-3557-000	
18	Orifice, high flow	1407-3920-000	
Active Low Flow with EVAC connector Specific Parts			
17b	Connector, low flow EVAC	1406-3597-000	
18	Orifice, low flow	1407-3919-000	
Active Low Flow with 25 mm connector Specific Parts			
17c	Connector, low flow 25 mm	1406-3573-000	
18	Orifice, low flow	1407-3919-000	
Active Low Flow with 12.7 mm hose barb connector Specific Parts			
17d	Connector, low flow 12.7 mm (1/2 inch)	1406-3574-000	
18	-none-		
Active Low Flow with 30 mm ISO male connector Specific Parts			
17e	Connector, 30 mm ISO, Male	1406-3555-000	
18	Orifice, low flow	1407-3919-000	

* Lubricate sparingly with Krytox


1
2
3
6 (5)

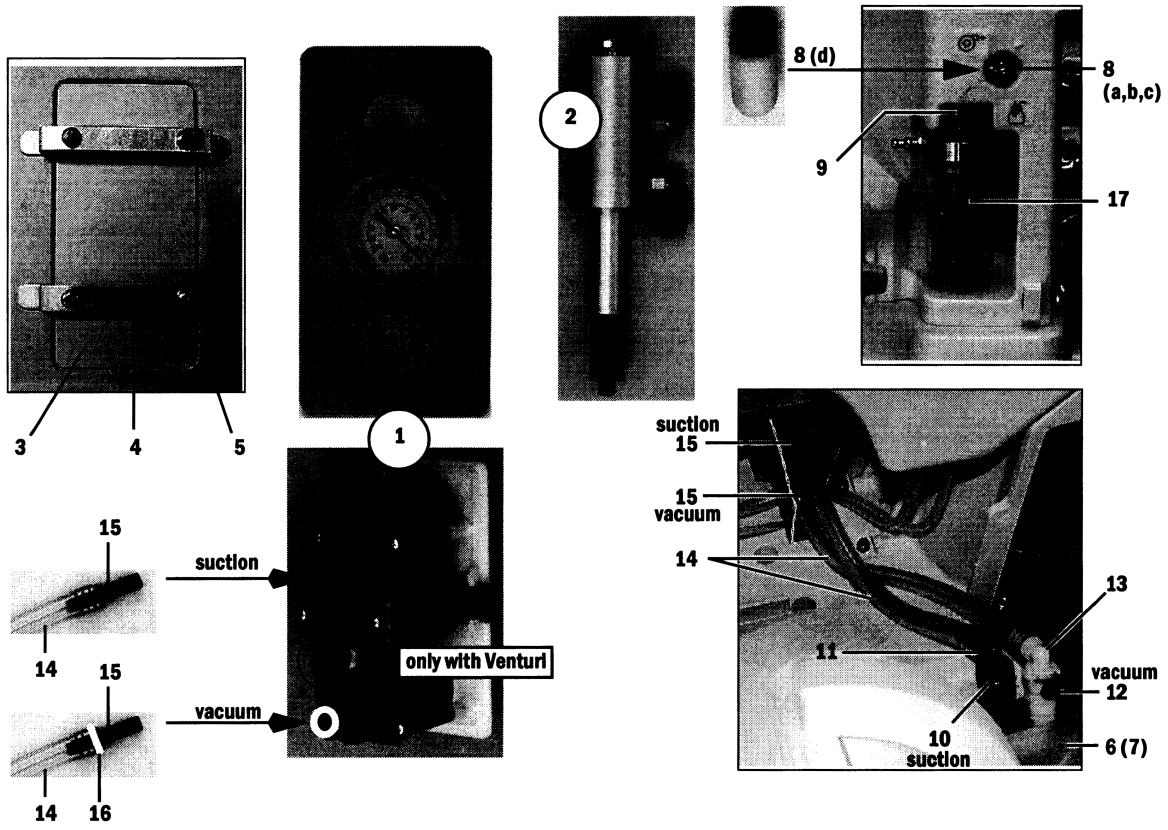

8
7
11
4 (5)
17
(10, 9)
15
16
14


or
12
13

17a
17b
17c
17d
17e

10.32 Integrated Suction Regulator

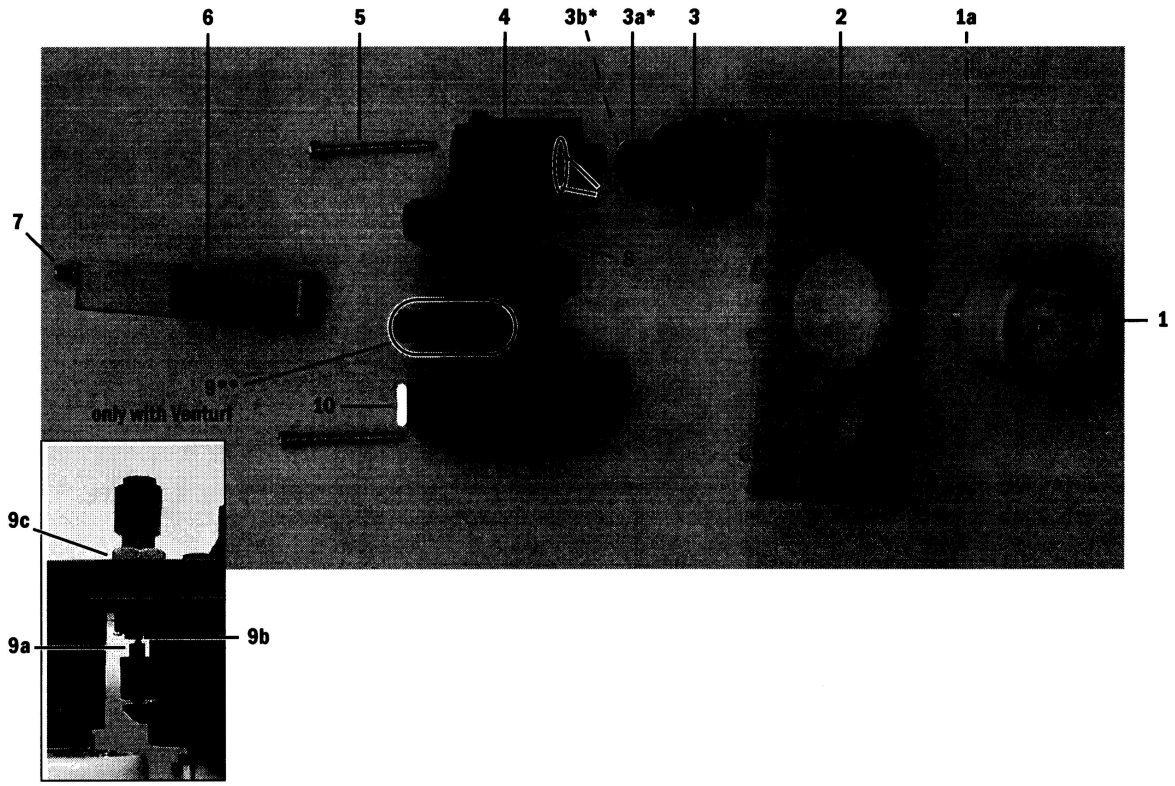
10.32.1 Major Components (Continuous and Venturi suction)



Item	Description	Stock Number
1	Suction Control Module	Refer to section 10.32.2
2	Venturi Assembly	Refer to section 10.32.3
3	Cover, blank (if no Suction)	1009-3271-000
4	Bracket, blank cover mounting	1009-3270-000
5	Screw, M4x10 self-tapping	1009-5534-000
6	Manifold	1009-3123-000
7	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
8a*	Connector, NIST	1011-3524-000
8b*	Connector, Barb	0221-0702-300
8c*	Connector, Air Liquide	1009-8292-000
8d	Muffler, for Venturi Drive	1011-3511-000
9	Coupling, Colder insert metal	1009-3135-000
10	Coupling, Colder body black	1009-3373-000
11	Coupling, Colder insert black	1009-3374-000
12	Coupling, Colder body white	1009-3371-000
13	Coupling, Colder insert white	1009-3372-000
14	Tubing, Tygon	Refer to section 10.28
15	Fitting, barb to 8-mm Legris	1009-3137-000
16	Cap, white	1009-3385-000
17	Overflow Safety Trap	6700-0647-800

* Apply Teflon tape to threads (not 8d).

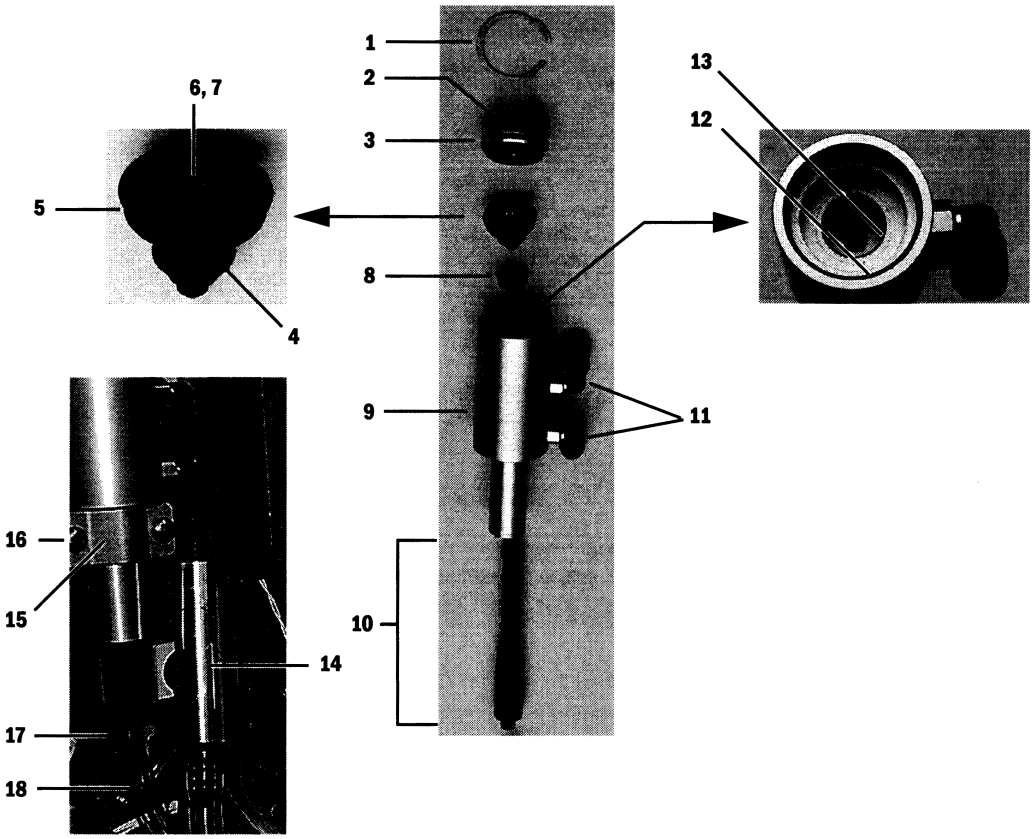
10.32.2 Suction Control Module



Item	Description	Stock Number
1	Gauge, 760 mmHg	1009-3227-000
	Gauge, 1 Bar	1009-3228-000
1a	O-ring, Gauge (included with gauge assy, 2ea. required)	6700-0133-500
2	Control panel assembly, with suction regulator knob and mode control knob	1009-3213-000
3	Regulator Module (plugs into manifold assembly)	6700-1225-800
3a	O-ring, Regulator Module, Large (included with regulator module)	6700-0136-500
3b	O-ring, Regulator Module, Stem (included with regulator module)	0210-0527-300
4	Manifold Assembly, without Gauge and Regulator Module	1009-3277-000
5	Screw, #6 - 2 inch	1009-3340-000
6	Mounting bracket	1009-3255-000
7	Screw, #6 - 1 inch	1009-3339-000
8	Filter	0206-5159-300
9	Pilot valve adapter assembly (includes plunger, jam nut, and valve assembly)	1009-3278-000
10	Cap, white	1009-3192-000

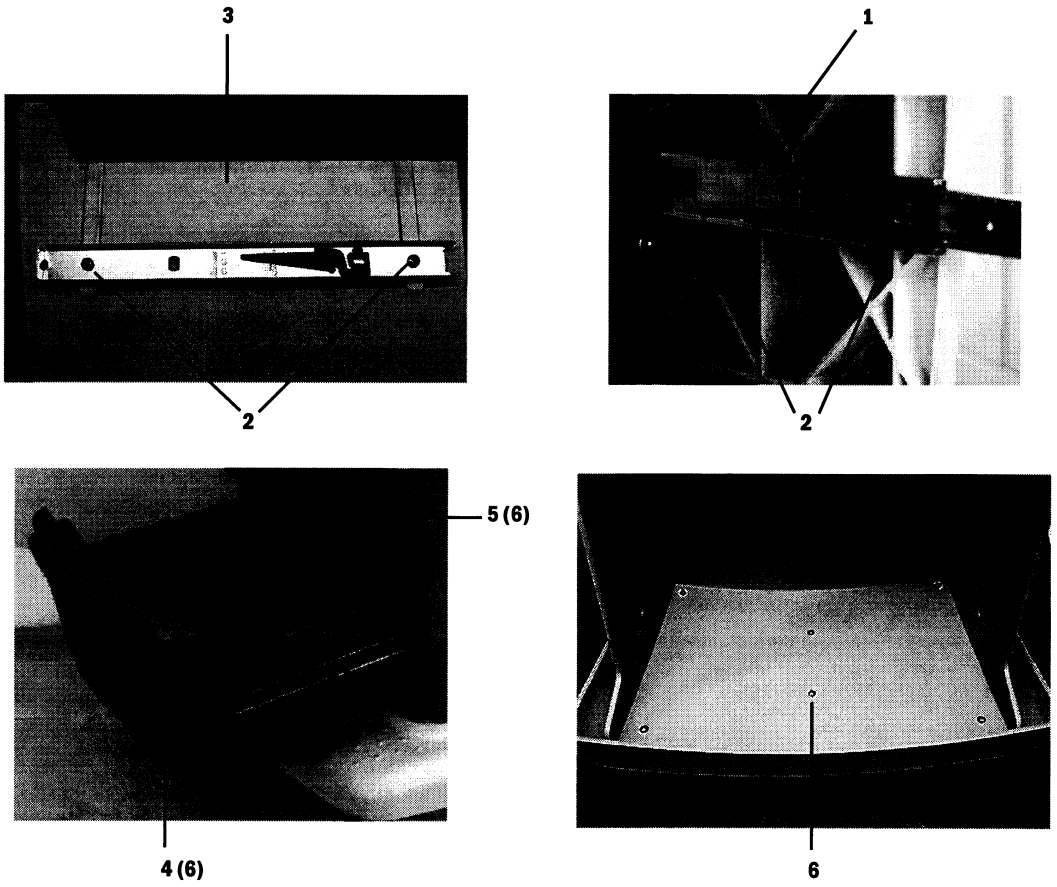
* Lubricate the regulator module o-rings and the mating bore of the manifold sparingly with Dow 111 lubricant.
** Drop the plunger (**9a**), round end first, into the manifold. Thread the pilot valve into the manifold body. Set the mode switch to raise the plunger. Adjust the pilot valve (**9b**) so that the plunger actuates the pilot valve approximately half of its travel. Tighten the jam nut (**9c**).

10.32.3 Venturi assembly



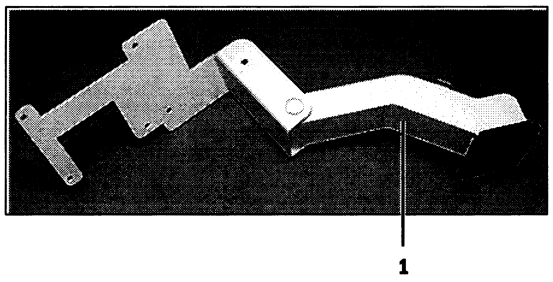
Item	Description	Stock Number
1	C-clip retainer, Truarc	1500-3158-000
2	Elbow fitting, 4-mm Legris	1006-3663-000
3	Cap	1011-5002-000
4	Spoppet	1011-5001-000
5	Seal, u-cup large	1503-3090-000
6	Orifice	1011-3508-000
7	Screen, 150 mesh monel	1001-3808-000
8	Seal, u-cup small	1503-3089-000
9	Body	1011-5000-000
10	Venturi	1011-3509-000
11	Elbow fitting, 8-mm Legris	1011-3510-000
12	O-ring, large	9221-3032-116
13	O-ring, small	1503-3108-000
14	Check valve	1011-8002-000
15	Bracket, Venturi mounting	1009-3182-000
16	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
17	Cable tie	0203-5915-300
18	Tubing, Tygon	Refer to section 10.27

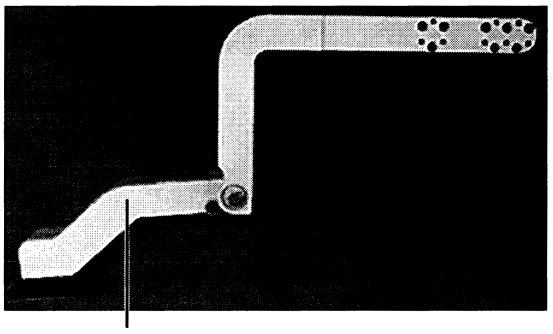
10.33 Drawer

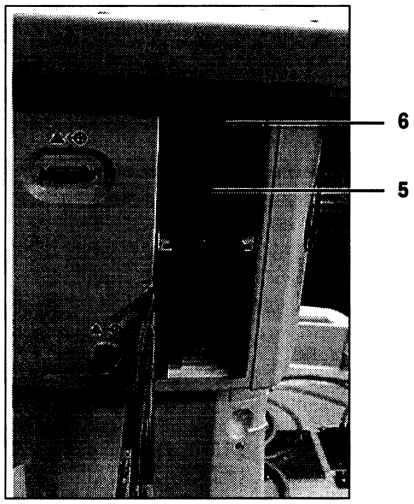


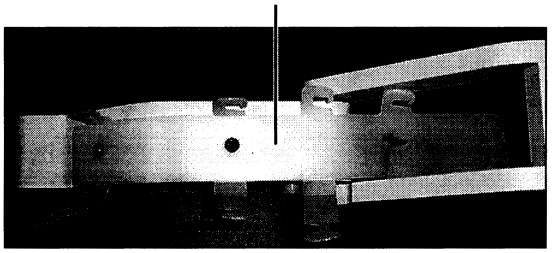
Item	Description	Stock Number
1	Slide, drawer	1009-3084-000
2	Screw, M4x8 Nyloc	1009-3183-000
3	Drawer, body	1009-3078-000
4	Drawer Front, lower (down arrow)	1009-3032-000
5	Drawer Front, upper (up arrow)	1009-3031-000
6	Screw, M4x12	1009-3109-000

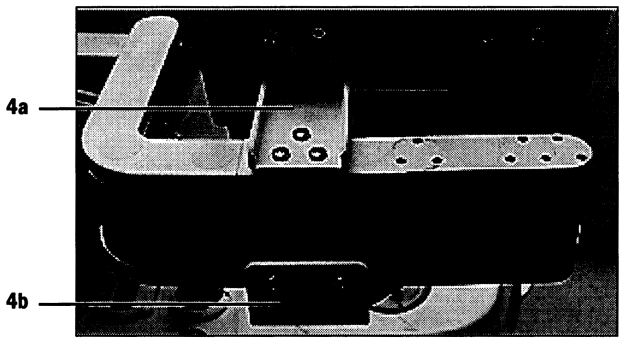
10.34 Display mounts







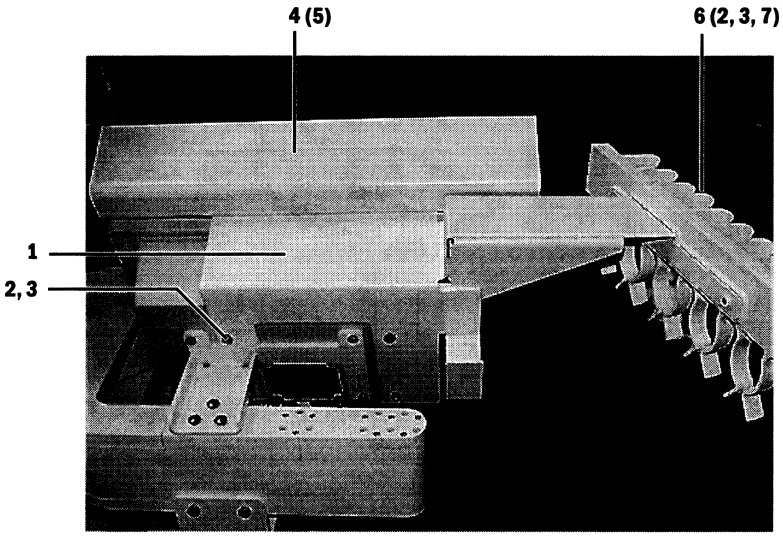




Item	Description	Stock Number
1	GCX Arm Kit, short includes display arm and fasteners	1009-3264-000
2	GCX Arm Kit, long	1009-3262-000
3	Cable Guide Kit, for long arm	1009-8473-000
4	GCX Bracket Kit, includes display mount (4a), cable guard (4b), and mounting hardware	1009-3263-000
5	Extrusion, upper dovetail	1009-3113-000
6	Screw, M6x20	0144-2131-925
*	Cable ties	0203-5915-300

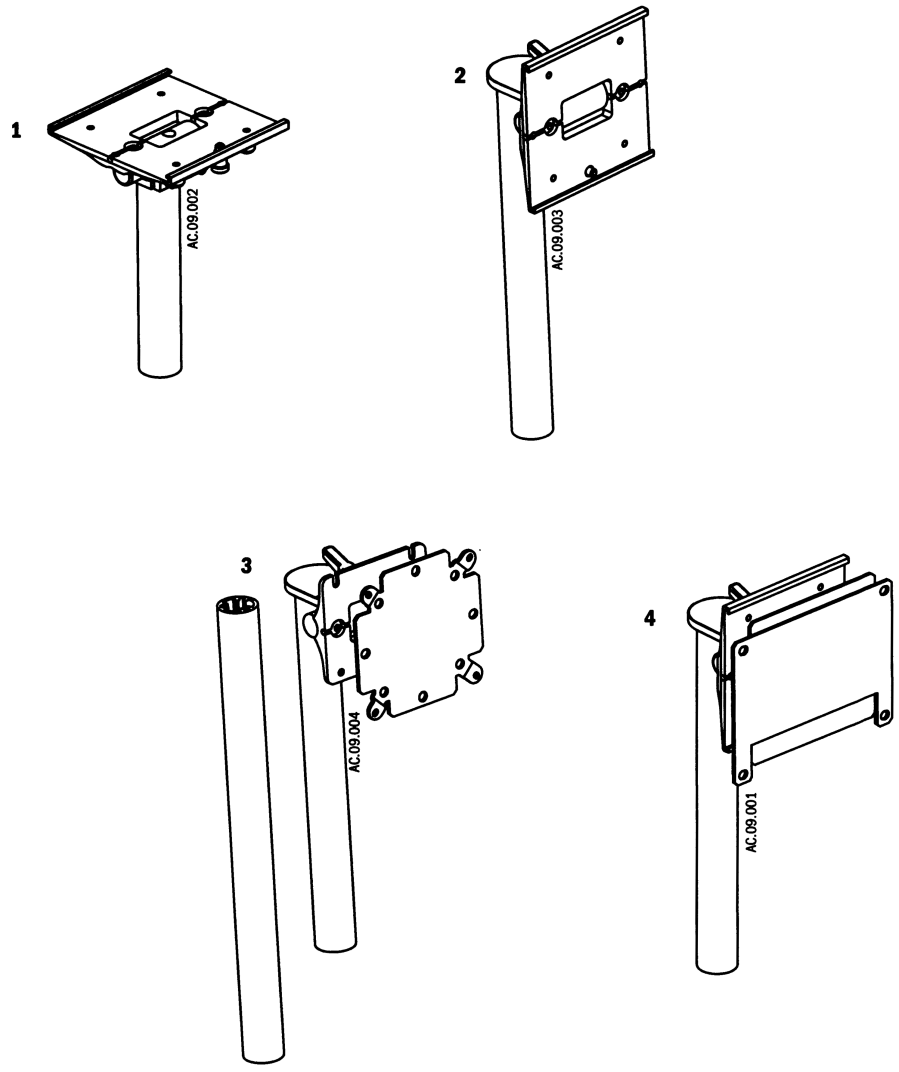
* Refer to Section 9.19 for mounting the display arms and proper cable dressing.

10.35 Cable management arm



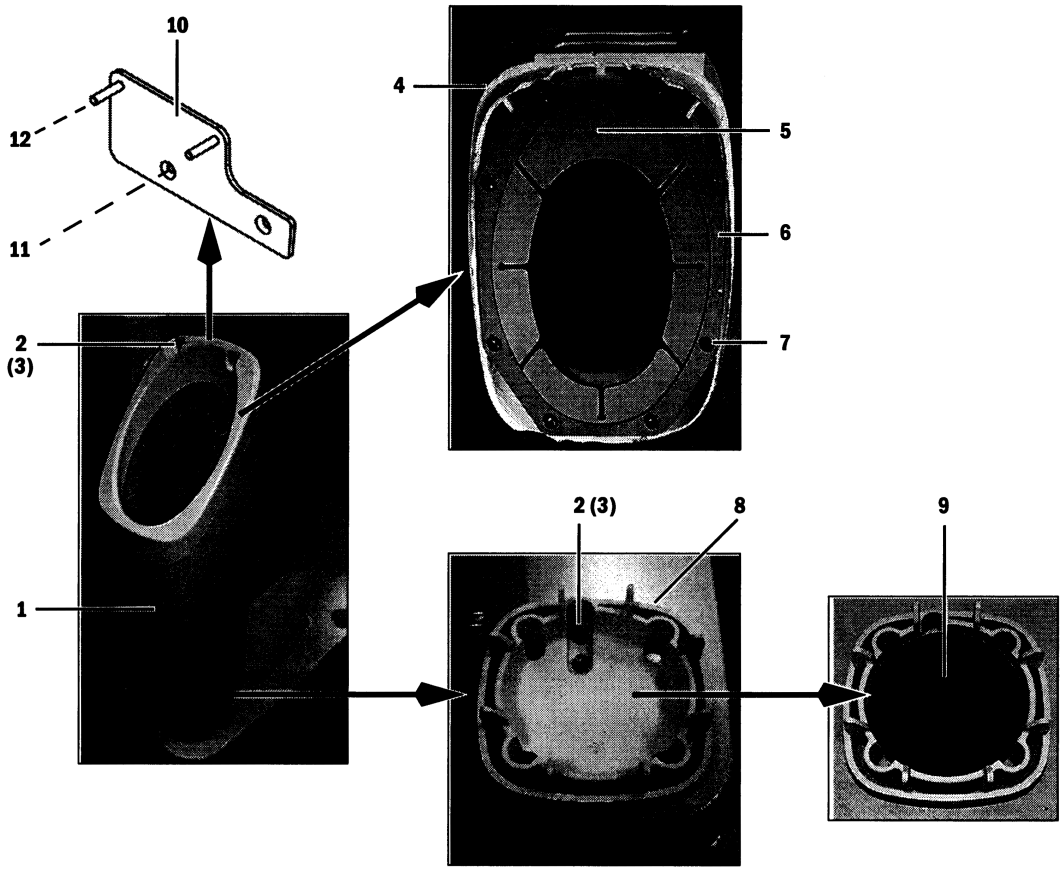
Item	Description	Stock Number
	Cable management arm, complete assembly	1009-8283-000
1	Bracket, cable management	1009-3261-000
2	Screw, M4x12	0140-6226-111
3	Lockwasher, M4 external	9213-0540-003
4	Extrusion, cable arm, front loading	1009-3247-000
5	Screw, M4x6 Nyloc	1009-3283-000
6	Retainer, multiple cable	1009-3252-000
7	Washer, M4 flat	0144-1025-165

10.36 Display arm mounting kits for optional equipment



Item	Description	Stock Number
1	Cardiocap 5 mount	1009-3265-000
2	S/5 Flat Panel mount	1009-3266-000
3	Spacelabs Flat Panel mount	1009-3267-000
4	Spacelabs PC Scout mount	1009-3268-000

10.37 Outboard cylinder mount



Item	Description	Stock Number
	Outboard cylinder mount kit for Aisys (includes items 1 through 9)	1011-8090-000
	Outboard cylinder mount kit for Aespire (includes items 1 through 12)	1011-8091-000
1	Shroud, Auxiliary Cylinder	1011-3908-000
2	Screw, M5X25 Pan Head Pozidriv	0144-2531-916
3	Lockwasher, M5 External	0144-1118-220
4	Cap	1011-3906-000
5	Bumper	1011-3909-000
6	Retainer	1011-3924-000
7	Screw, M4x8 Sems Pozidriv	0140-6226-113
8	Base, Auxiliary Cylinder	1011-3907-000
9	Pad, Auxiliary Cylinder	1011-3911-000
10	Bracket, Auxiliary Cylinder (not required for Aisys)	1011-3372-000
11	Screw, M5X12 Flat Head Socket	0144-2117-725
12	Nut, Keps M5	0144-3717-324

Notes

11 Schematics and Diagrams

In this section

Schematics are subject to change without notice.

Circuit boards are available only as complete assemblies.

Figure 11-1 System connection block diagram 11-2

Figure 11-2 Gas scavenging circuits 11-3

Figure 11-3 Electrical cabling block diagram 11-4

Figure 11-4 Pneumatic circuit diagram 11-5

Figure 11-5 Wiring harnesses 11-6

Figure 11-6 Wiring harnesses (Aespire 100) 11-7

Figure 11-7 Tubing 11-8

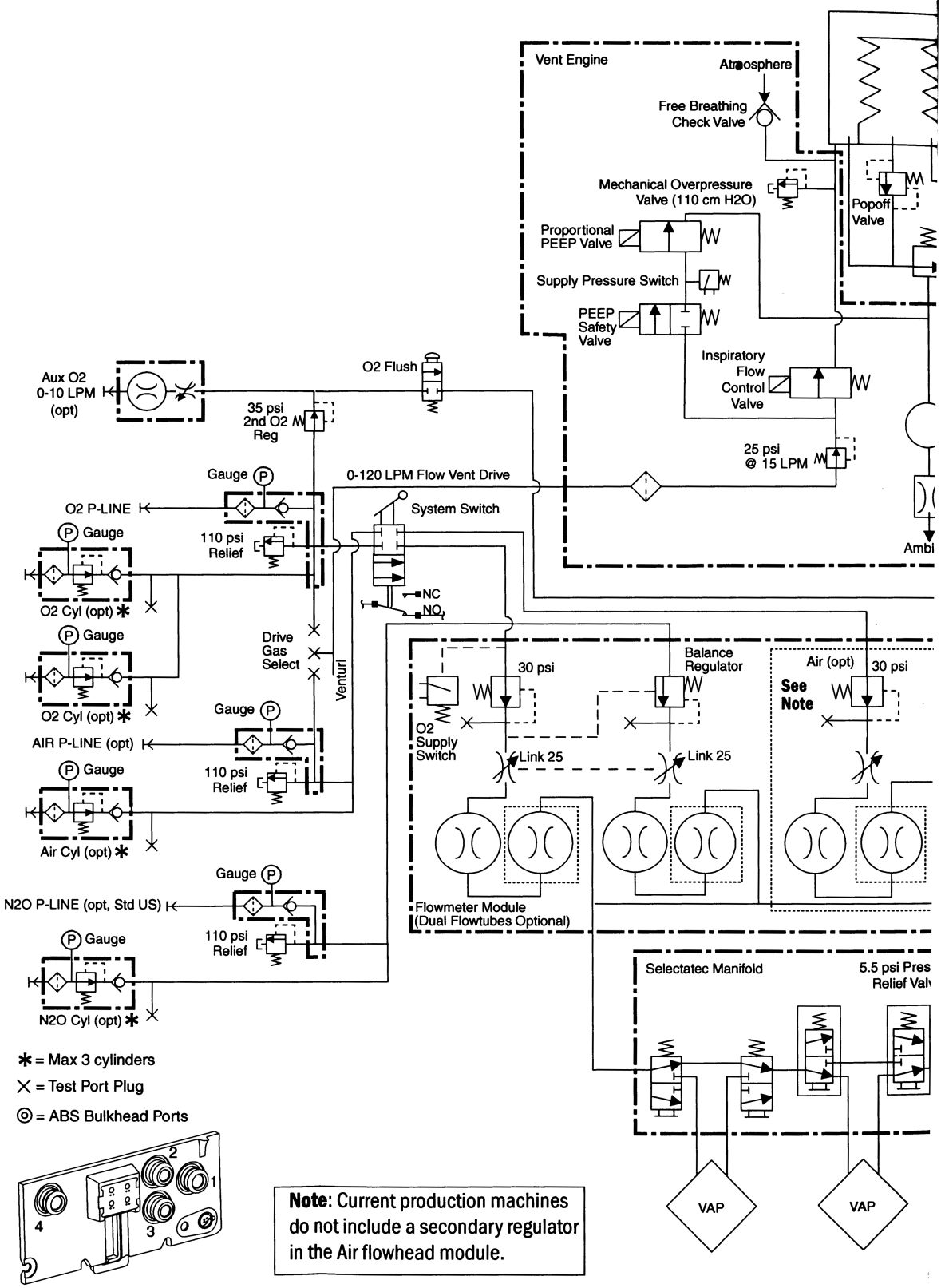
Figure 11-8 Schematic, AC Inlet module; 100–120 V (Non-isolated outlets or no outlets) 11-9

Figure 11-9 Schematic, AC Inlet module; 100–120 V (Isolated outlets) 11-10

Figure 11-10 Schematic, AC Inlet module; 220–240 V (Non-isolated outlets or no outlets) 11-11

Figure 11-11 Schematic, AC Inlet module; 220–240 V (Isolated outlets) 11-12

Figure 11-12 Schematic, AC Power (Aespire 100) 11-13



Note: Current production machines do not include a secondary regulator in the Air flowhead module.

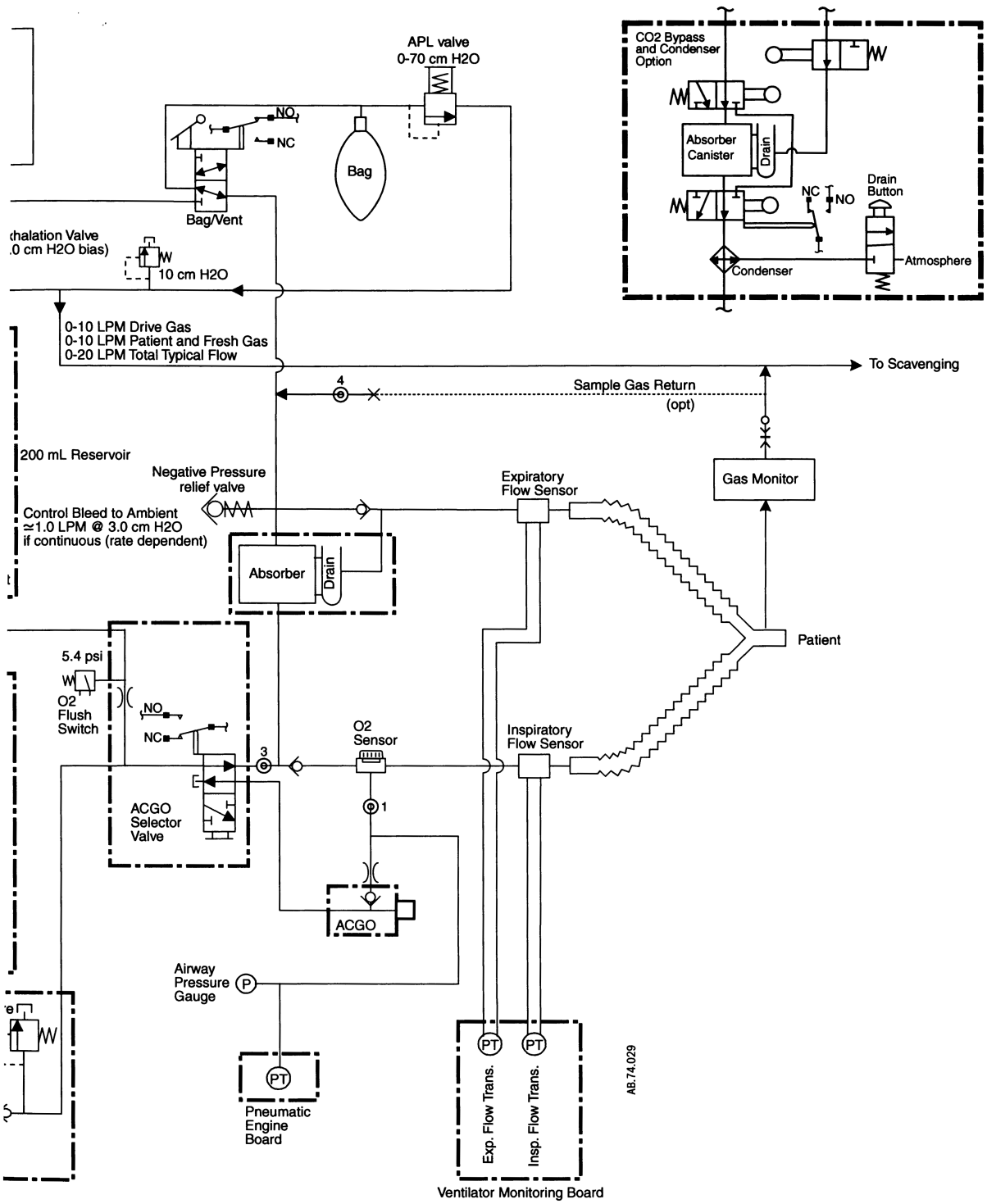
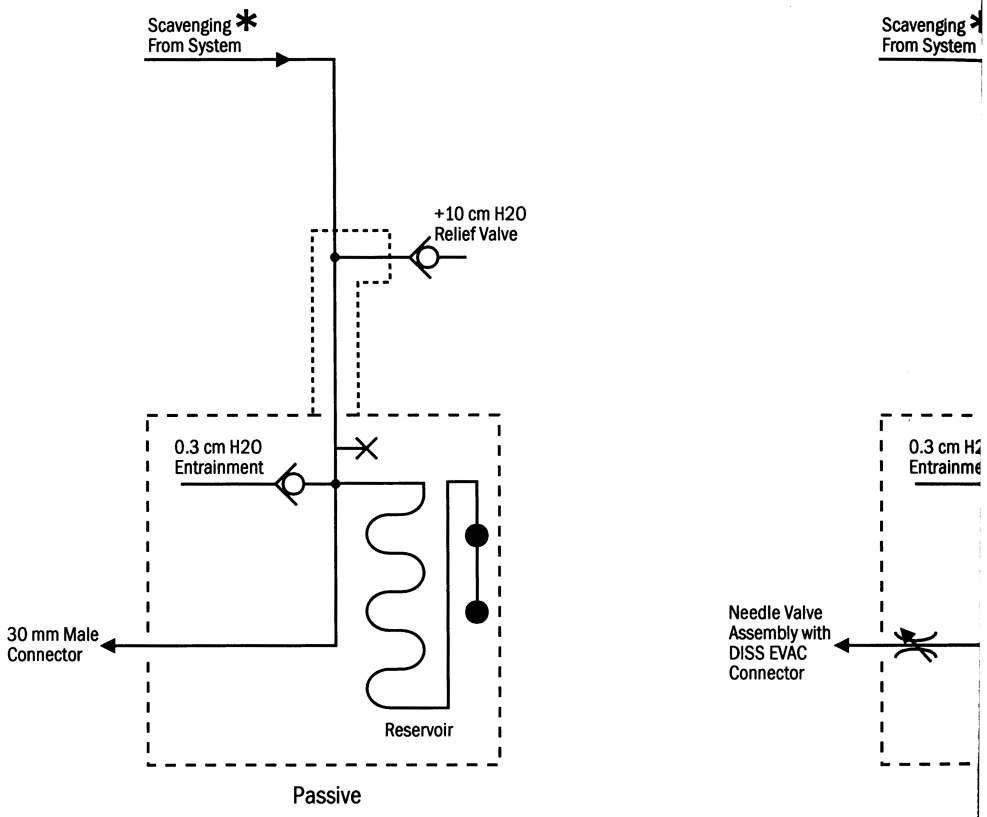


Figure 11-1 • System connection block diagram

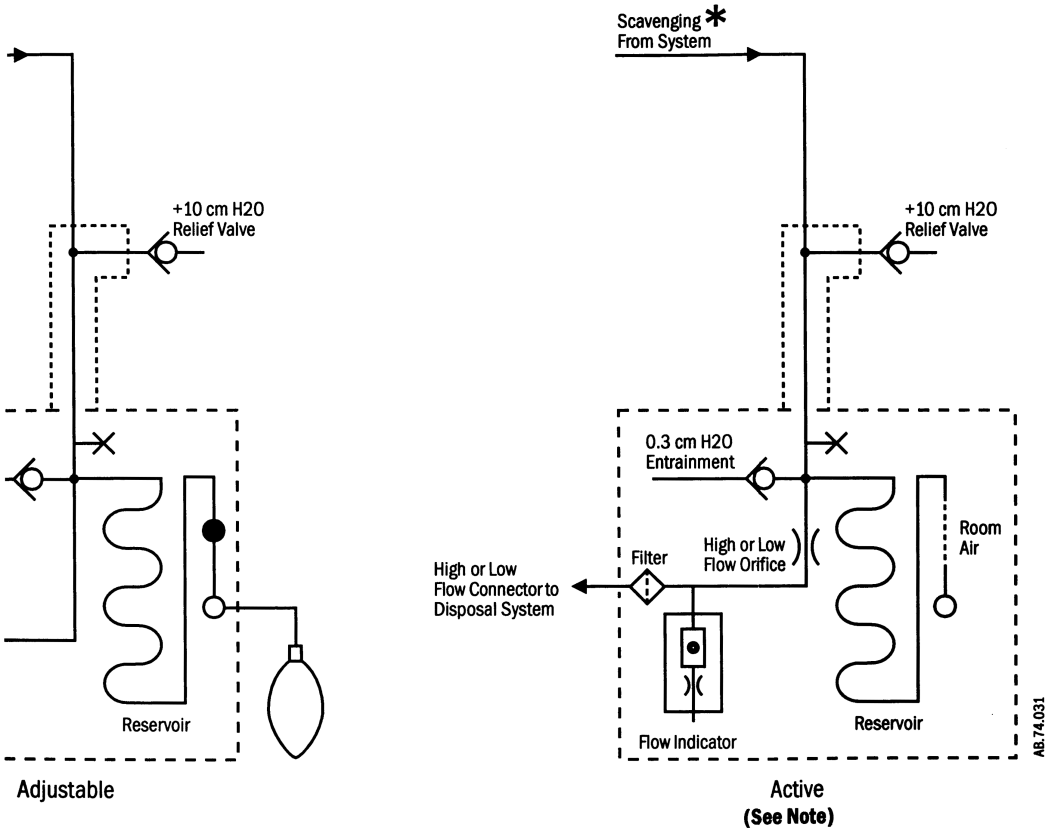


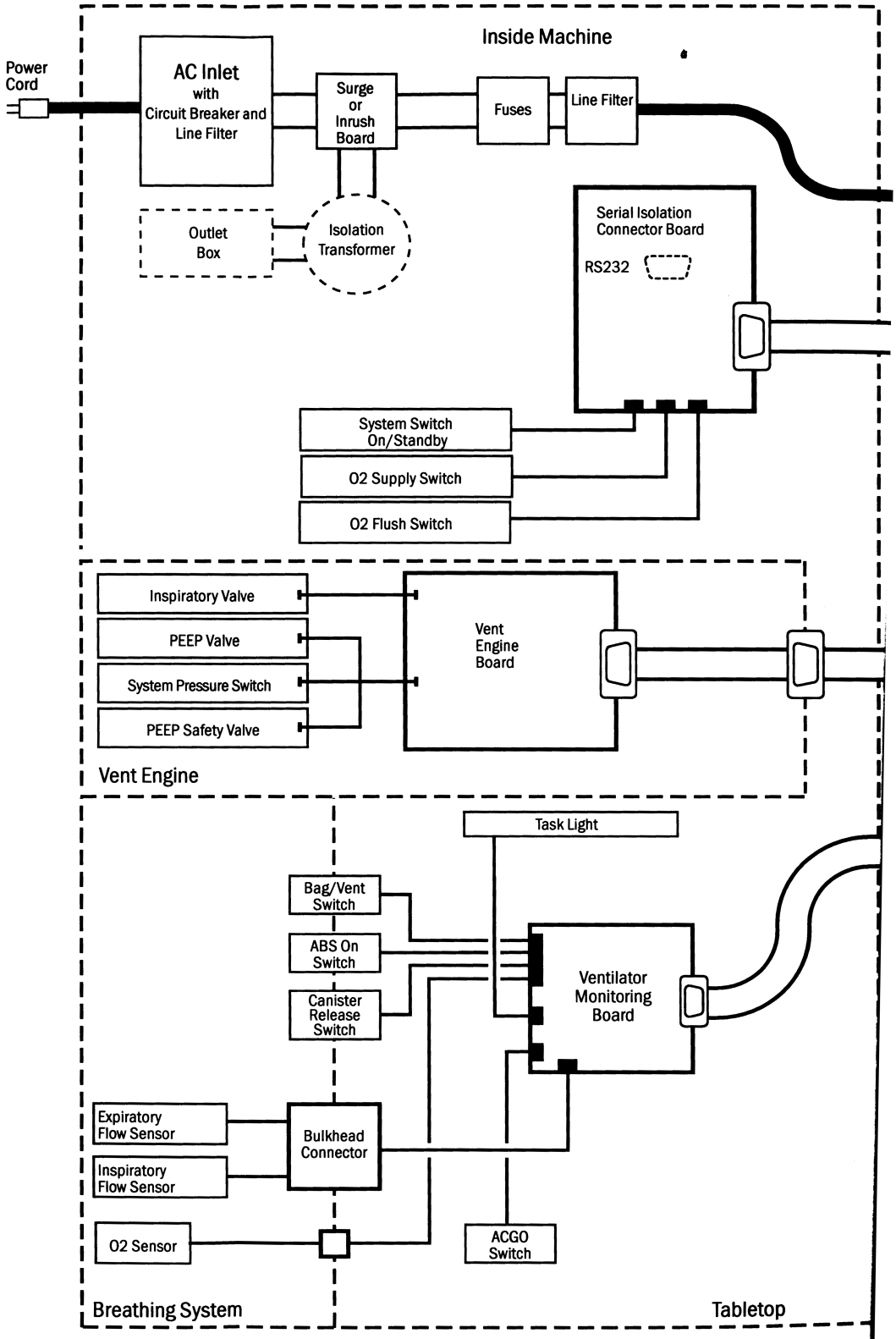
Key to Symbols

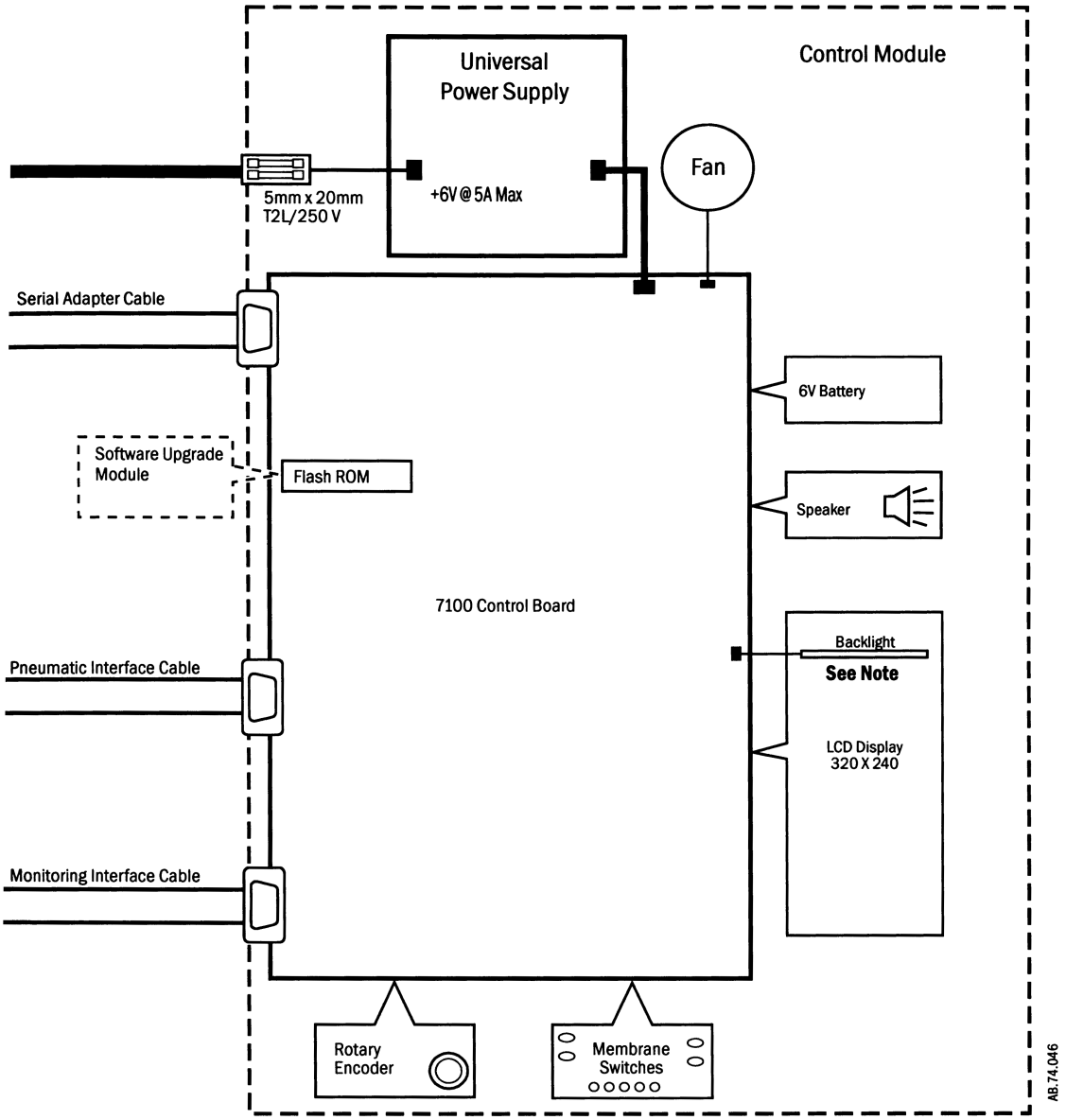
- ✕ = Plugged port (1/8 inch) for sample gas return.
- ● = Plugged port (30 mm) for auxiliary breathing system scavenging.
- ○ = Open port (30 mm) for auxiliary breathing system scavenging.
- ✱ = Zero to 10 l/min drive gas; zero to 10 l/min patient and fresh gas; zero to 20 l/min total typical flow.

Note: Active AGSS systems with a 12.7 mm connector do not include the Flow Orifice and the Flow Indicator.

Figure 11-2 • Gas scavenging circuits


+10 cm H2O
Relief Valve
Reservoir
Adjustable
Scavenging *
From System
+10 cm H2O
Relief Valve
0.3 cm H2O
Entrainment
High or Low
Flow Connector to
Disposal System
Filter
High or Low
Flow Orifice
Room
Air
Flow Indicator
Reservoir
Active
(See Note)
AB.74.031


Inside Machine
Power Cord
AC Inlet with Circuit Breaker and Line Filter
Surge or Inrush Board
Fuses
Line Filter
Outlet Box
Isolation Transformer
Serial Isolation Connector Board
RS232
System Switch On/Standby
O2 Supply Switch
O2 Flush Switch
Inspiratory Valve
PEEP Valve
System Pressure Switch
PEEP Safety Valve
Vent Engine Board
Vent Engine
Task Light
Bag/Vent Switch
ABS On Switch
Canister Release Switch
Ventilator Monitoring Board
Expiratory Flow Sensor
Inspiratory Flow Sensor
Bulkhead Connector
O2 Sensor
ACGO Switch
Breathing System
Tabletop



Note: For non-color displays, the backlight is powered through the control board, as shown. For color displays, the control module includes a separate circuit board to power the backlight.

Figure 11-3 • Electrical cabling block diagram

Key to Numbered Components

1. Pipeline pressure gauge
2. Pipeline inlet
3. Cylinder pressure gauge
4. Cylinder inlet
5. Primary regulator (cylinder pressure)
6. High-pressure relief valve (758 kPa / 110 psi)*
7. Supply connections for the ventilator
   a. O_2 drive gas
   b. Air drive gas
8. System switch
9. Switch for low O_2 supply pressure alarm (used with the ventilator)
10. O_2 secondary regulator (207 kPa / 30 psi)*
11. O_2 flow control valve
12. O_2 flow tube(s)
13. O_2 flush and auxiliary flowmeter regulator (241 kPa / 35 psi)*
14. O_2 Flush
    a. Flush valve
    b. Pressure switch (used with the ventilator)
15. N_2O balance regulator
16. N_2O flow control valve
17. N_2O flow tube(s)
18. Air secondary regulator (207 kPa / 30 psi)*
19. Air flow control valve
20. Air flow tube(s)
21. Supply connection for Venturi suction
    a. O_2 drive gas
    b. Air drive gas
22. Vaporizer port valve
23. Vaporizer
24. Low-pressure relief valve (38 kPa / 5.5 psi)*
25. Auxiliary flowmeter (optional)
26. To ABS
27. To ACGO
28. Test port (primary regulator)
29. Test port (secondary/balance regulator)

* Approximate values

Note: Current production machines do not include a secondary regulator (**18**) in the Air flowhead module.

Key to Symbols

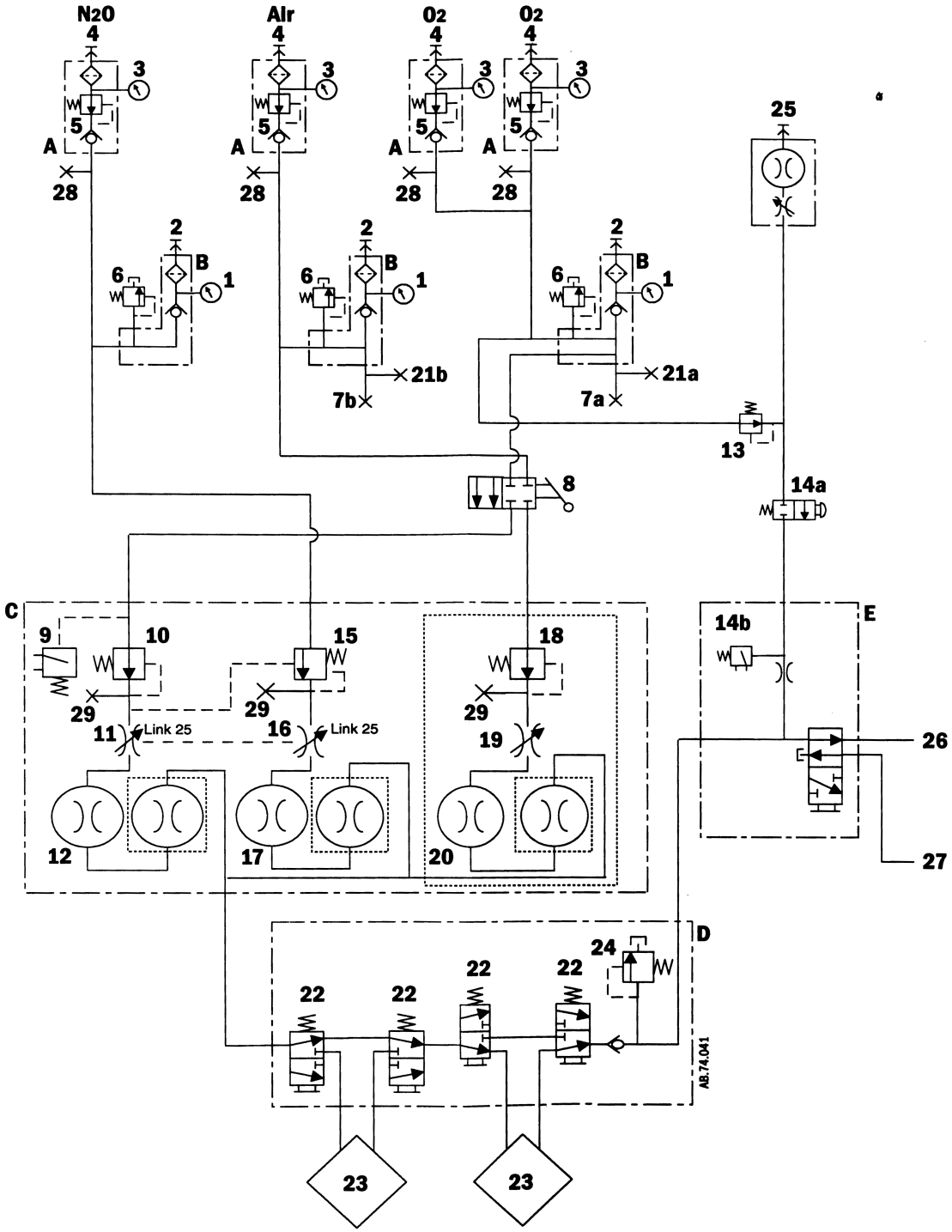
Pneumatic Connection

Filter

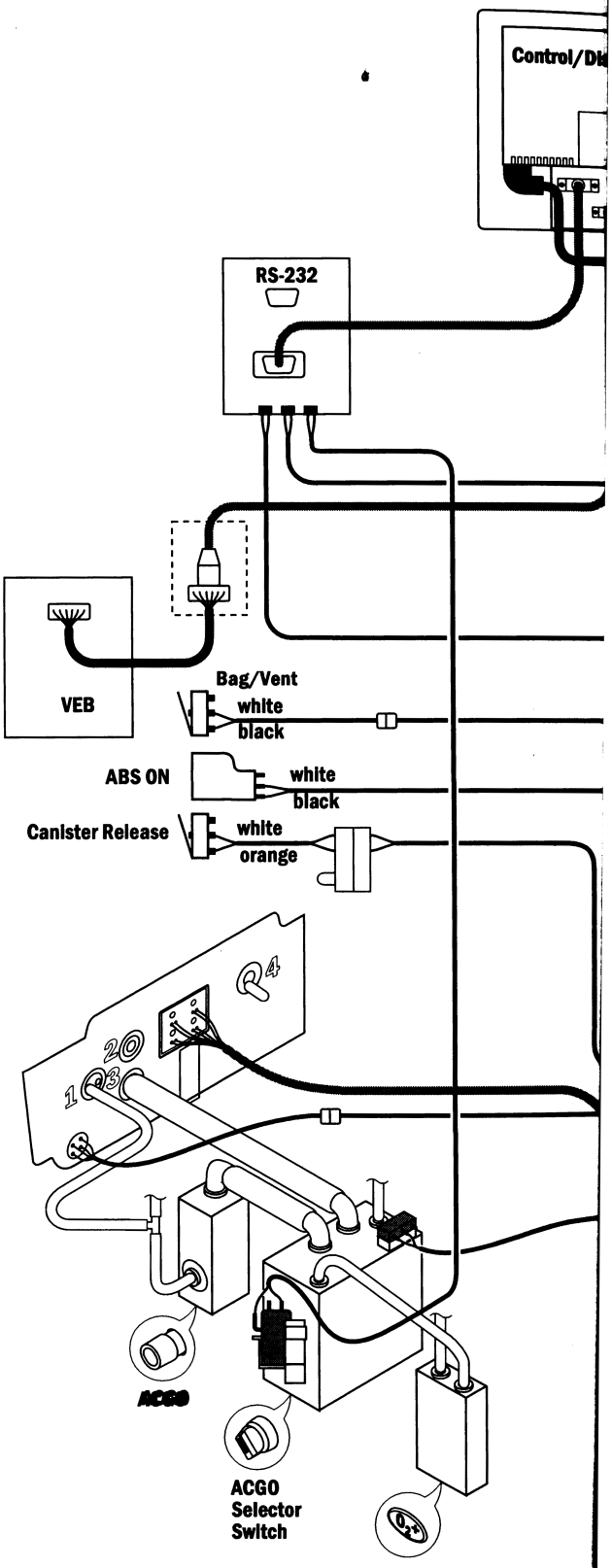
Direction of Flow

Check Valve

Figure 11-4 • Pneumatic circuit diagram



A. Cylinder Supplies
B. Pneumatic Manifold
C. Flowmeter Head
D. Vaporizer Manifold
E. ACGO Select Switch



Key to Symbols

VEB = Vent Engine Board

VMB = Ventilator Monitoring Board

ACGO = Auxiliary Common Gas Outlet

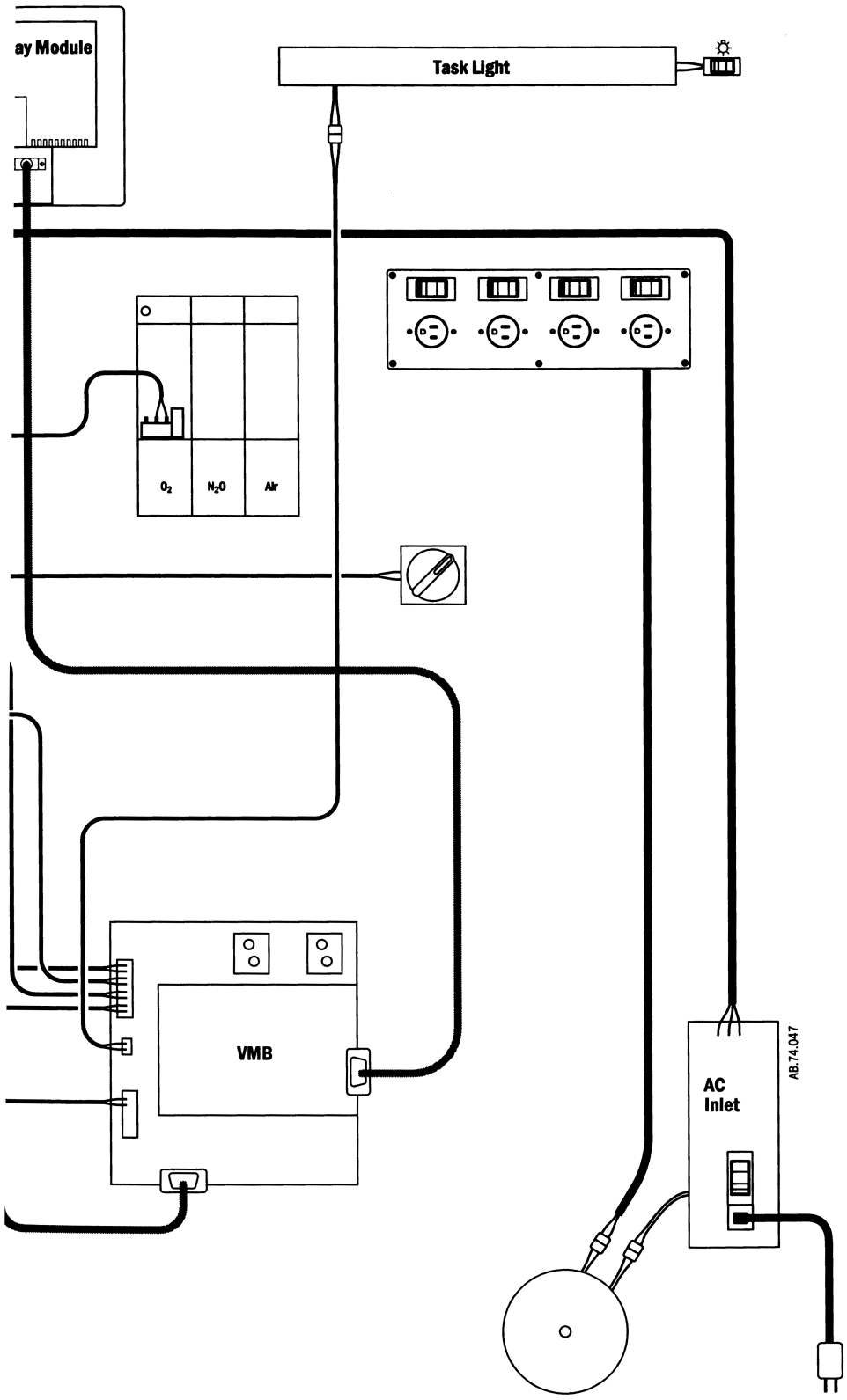
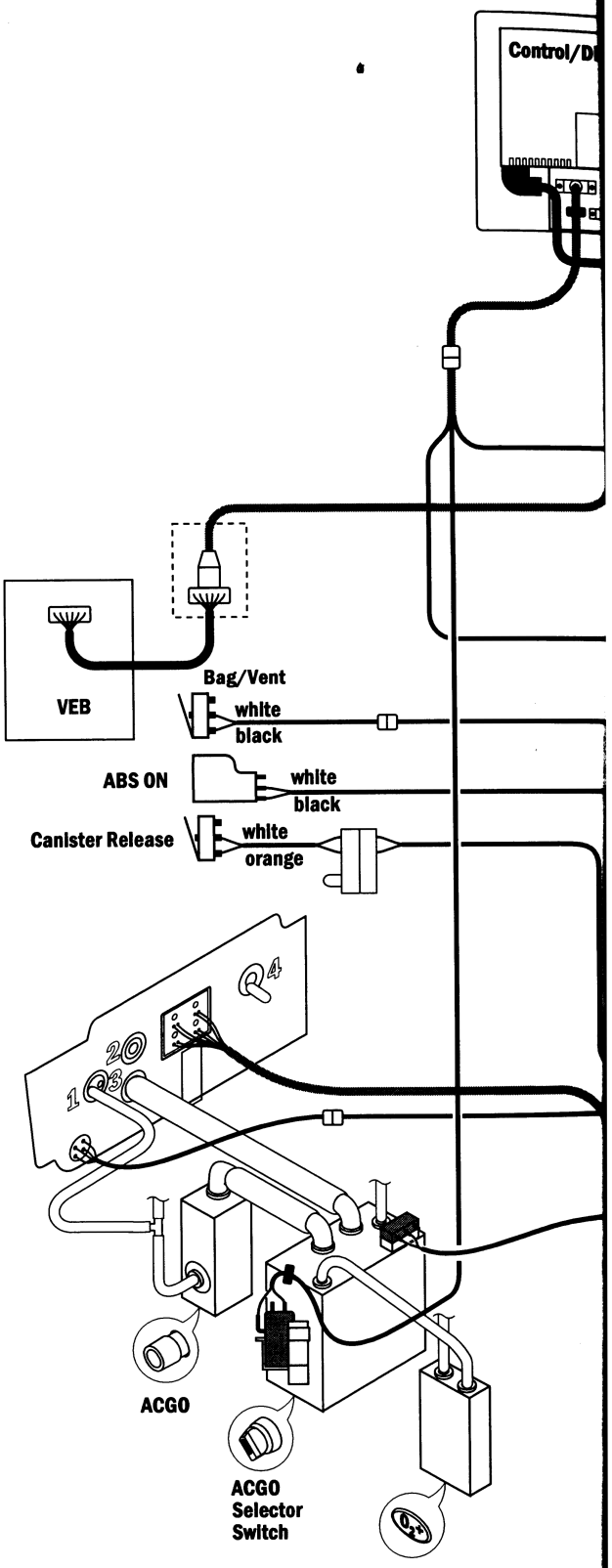


Figure 11-5 • Wiring harnesses



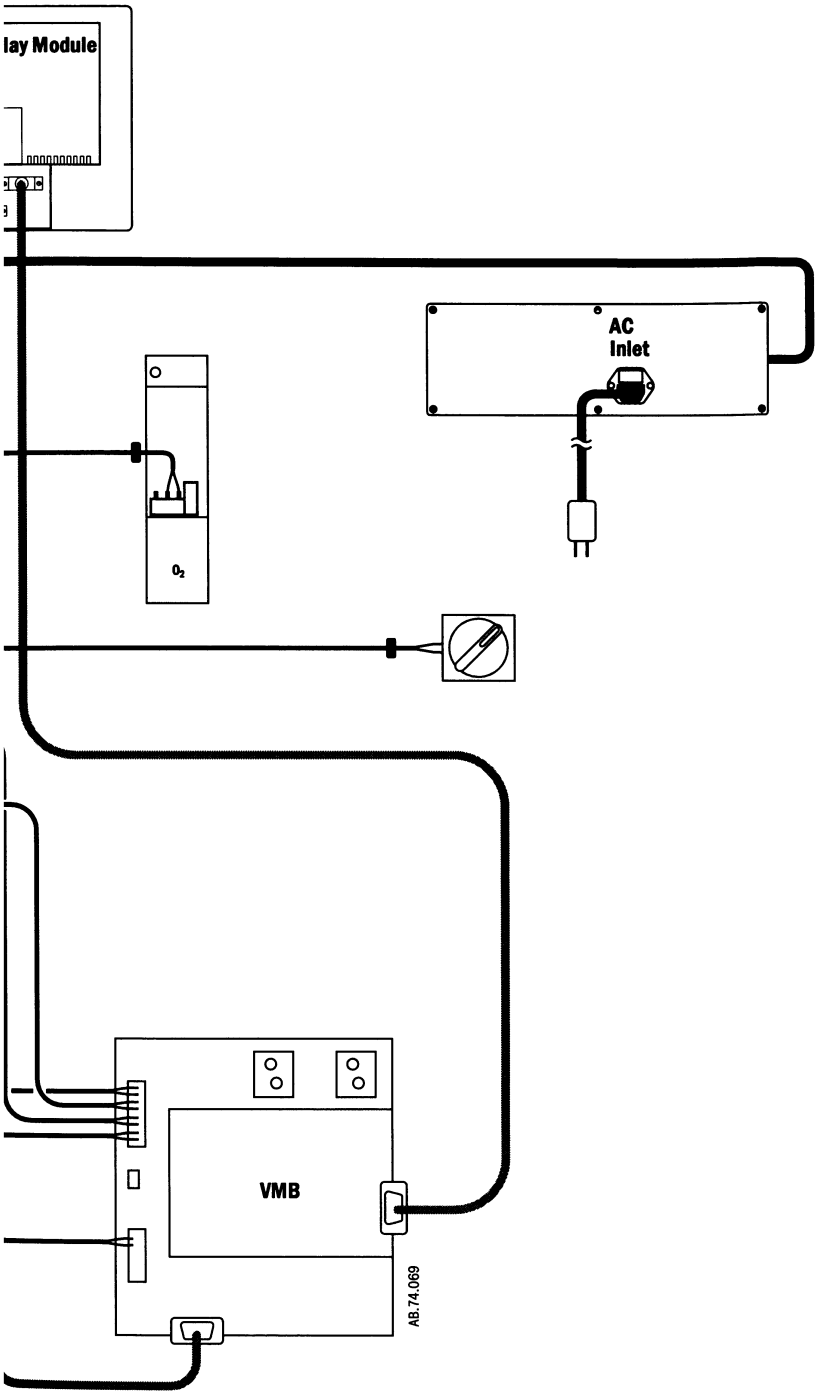
Key to Symbols

VEB = Vent Engine Board

VMB = Ventilator Monitoring Board

ACGO = Auxiliary Common Gas Outlet

Figure 11-6 • Wiring harnesses (Aespire 100)


lay Module
AC
Inlet
O_2
VMB
AB.74.069

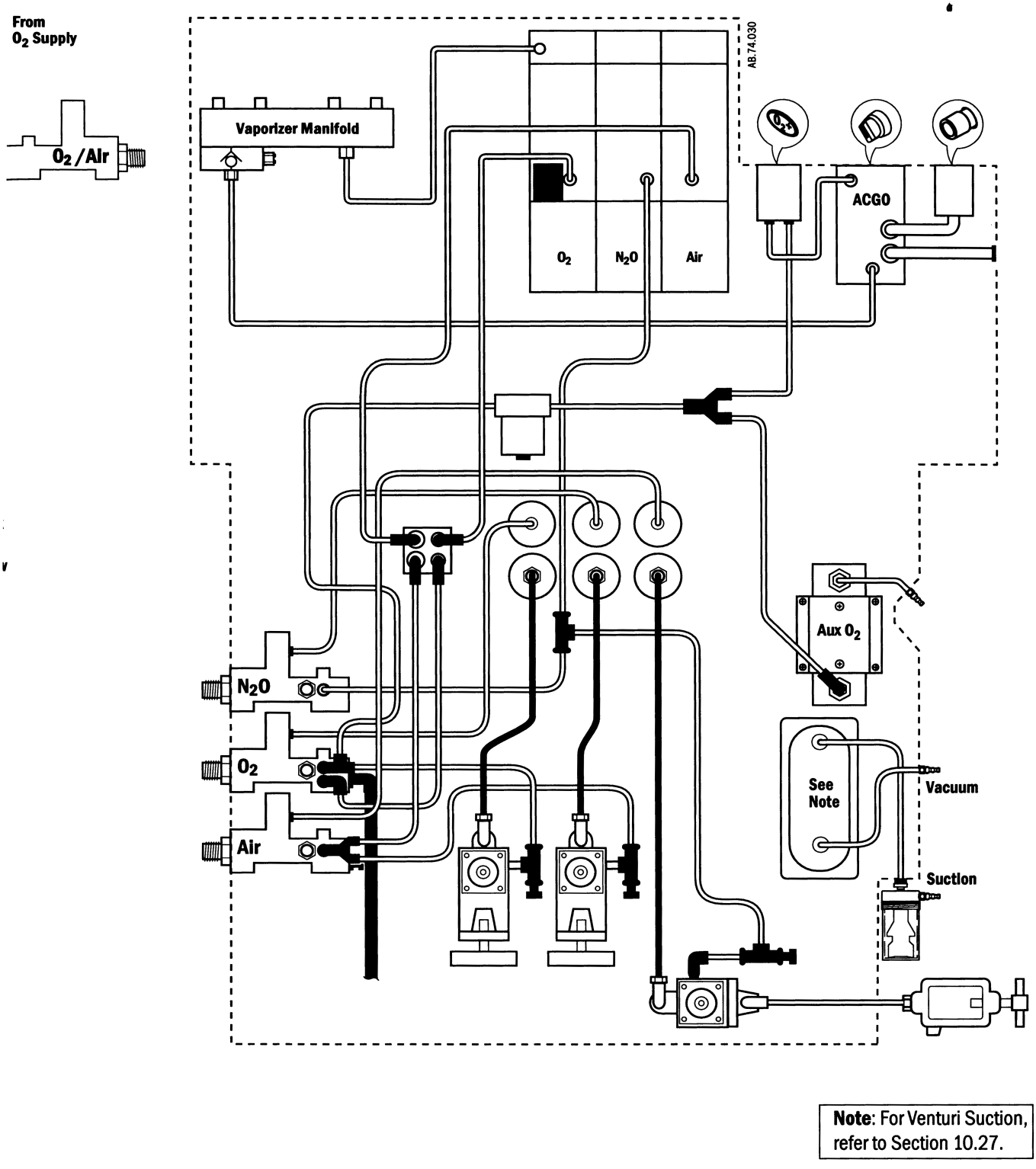
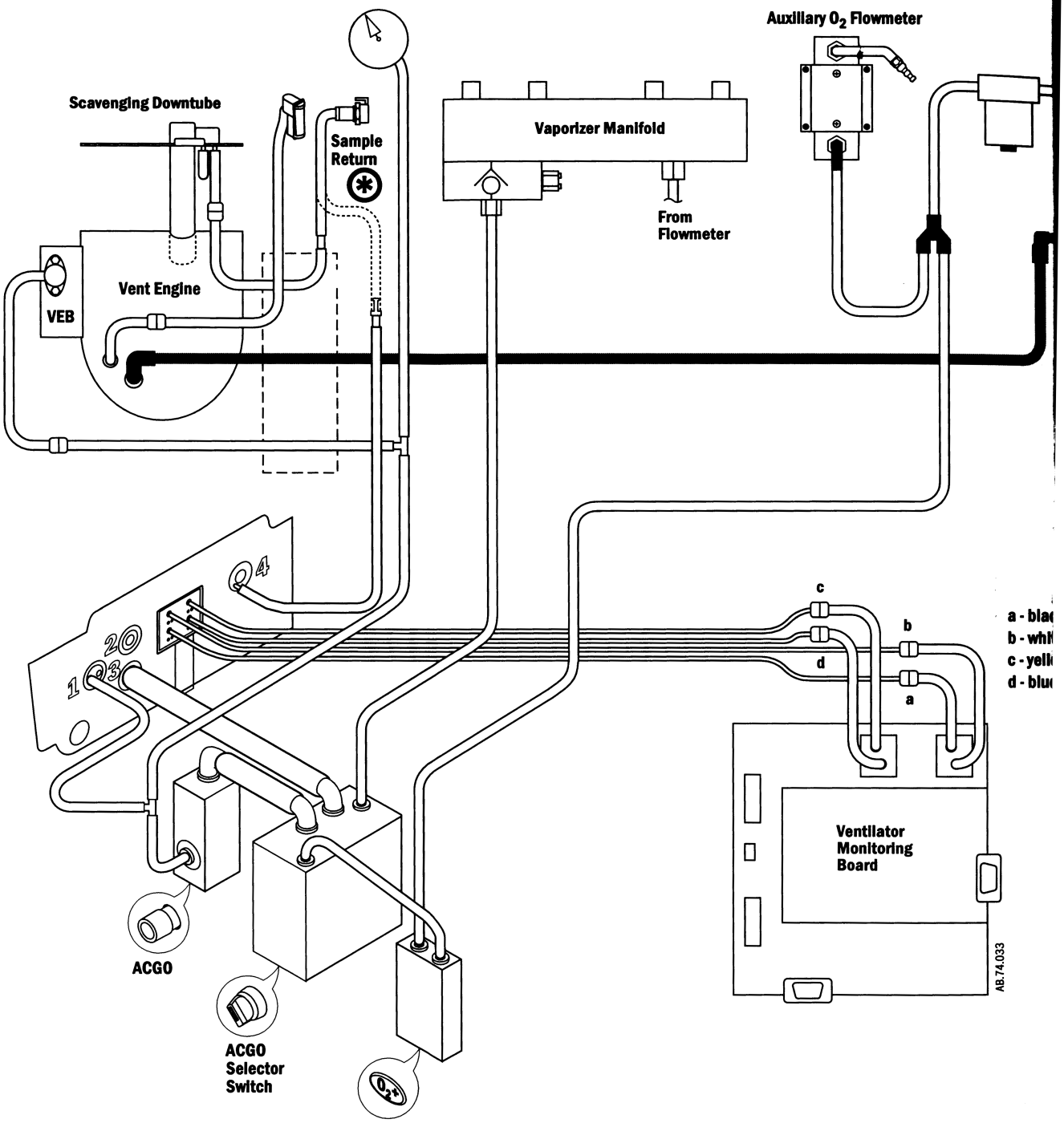


Figure 11-7 • Tubing



The Sample Gas Return is directed to the scavenging system as a factory default. A qualified service representative can reroute the sample gas back to the breathing system. Refer to Section 9.11.

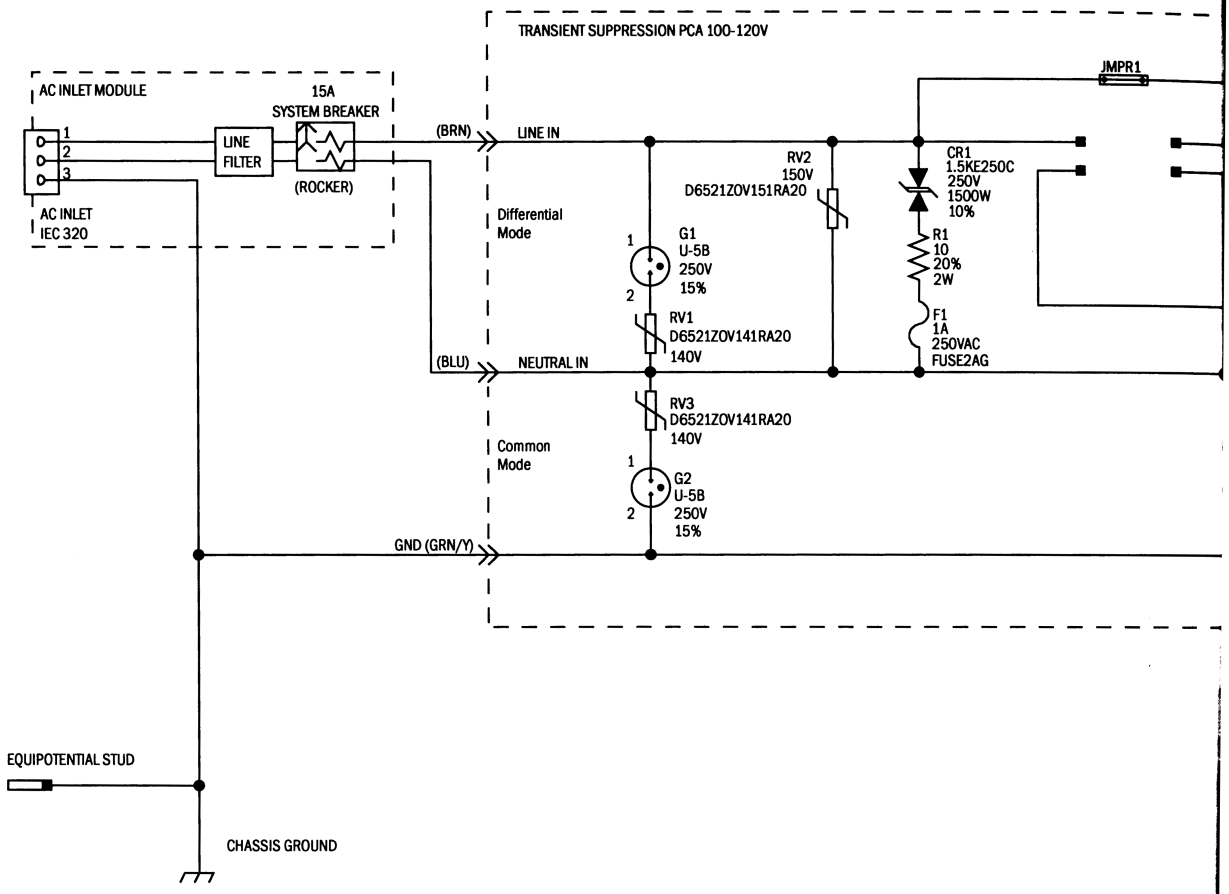
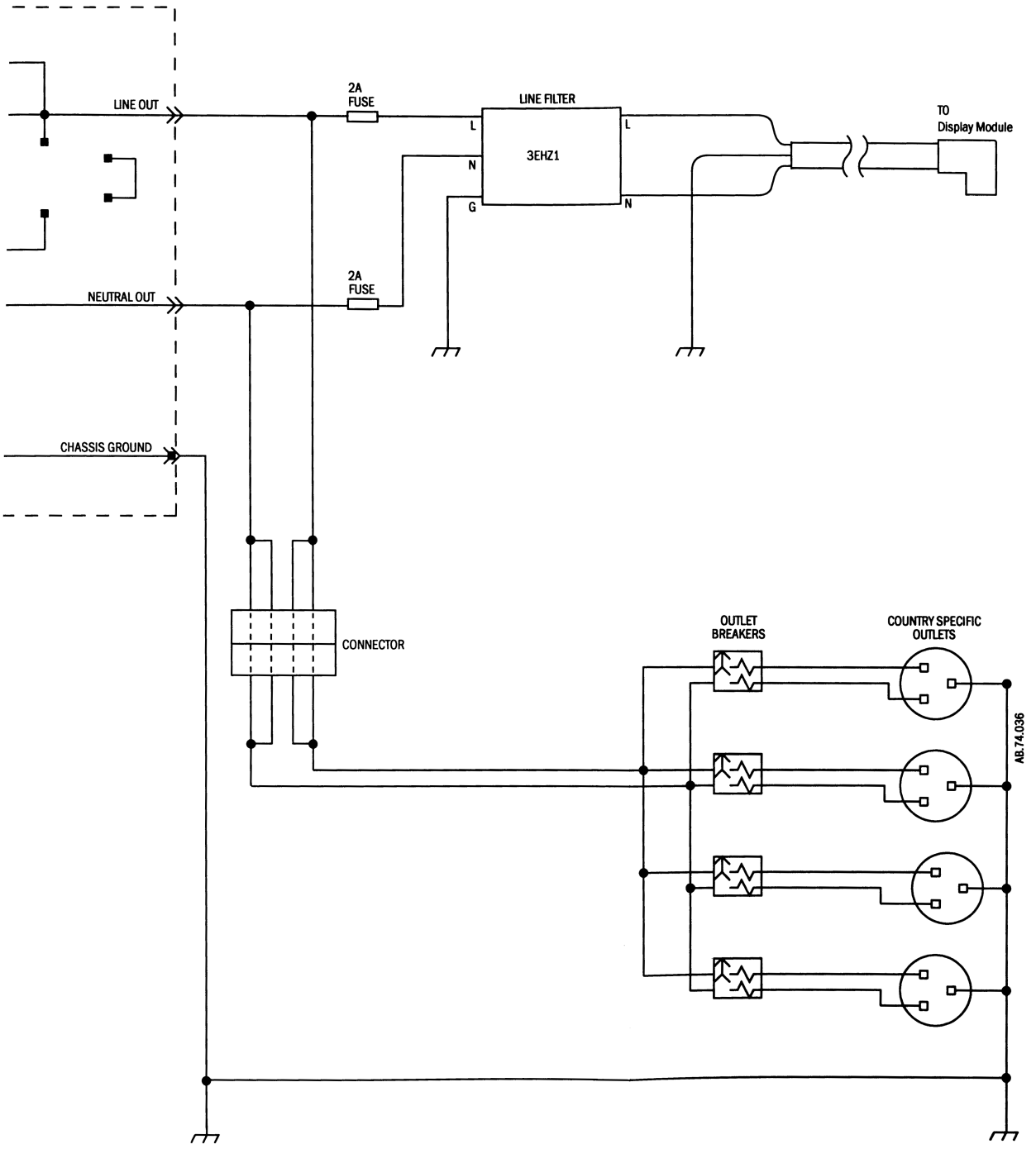
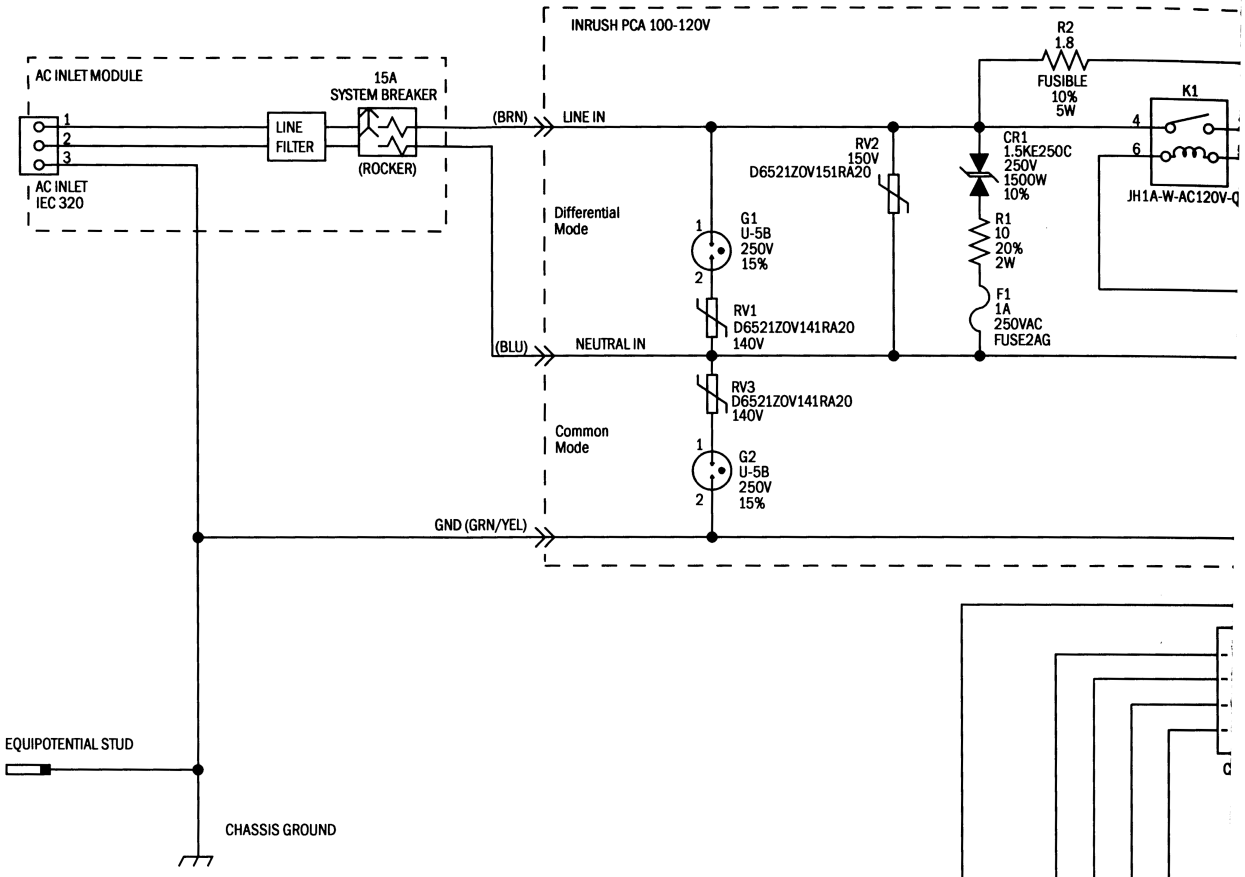


Figure 11-8 • Schematic, AC Inlet module; 100–120 V (Non-isolated outlets or no outlets)


LINE OUT
NEUTRAL OUT
CHASSIS GROUND
2A
FUSE
2A
FUSE
LINE FILTER
3EHZ1
L
N
G
L
N
TO
Display Module
CONNECTOR
OUTLET
BREAKERS
COUNTRY SPECIFIC
OUTLETS
AB.74.036


INRUSH PCA 100-120V
AC INLET MODULE
15A
SYSTEM BREAKER
LINE
FILTER
(ROCKER)
AC INLET
IEC 320
(BRN)
LINE IN
(BLU)
NEUTRAL IN
GND (GRN/YEL)
Differential
Mode
Common
Mode
G1
U-5B
250V
15%
G2
U-5B
250V
15%
RV1
D6521Z0V141RA20
140V
RV2
150V
D6521Z0V151RA20
RV3
D6521Z0V141RA20
140V
R2
1.8
FUSIBLE
10%
5W
CR1
1.5KE250C
250V
1500W
10%
R1
10
20%
2W
F1
1A
250VAC
FUSE2AG
K1
JH1A-W-AC120V-Q
EQUIPOTENTIAL STUD
CHASSIS GROUND

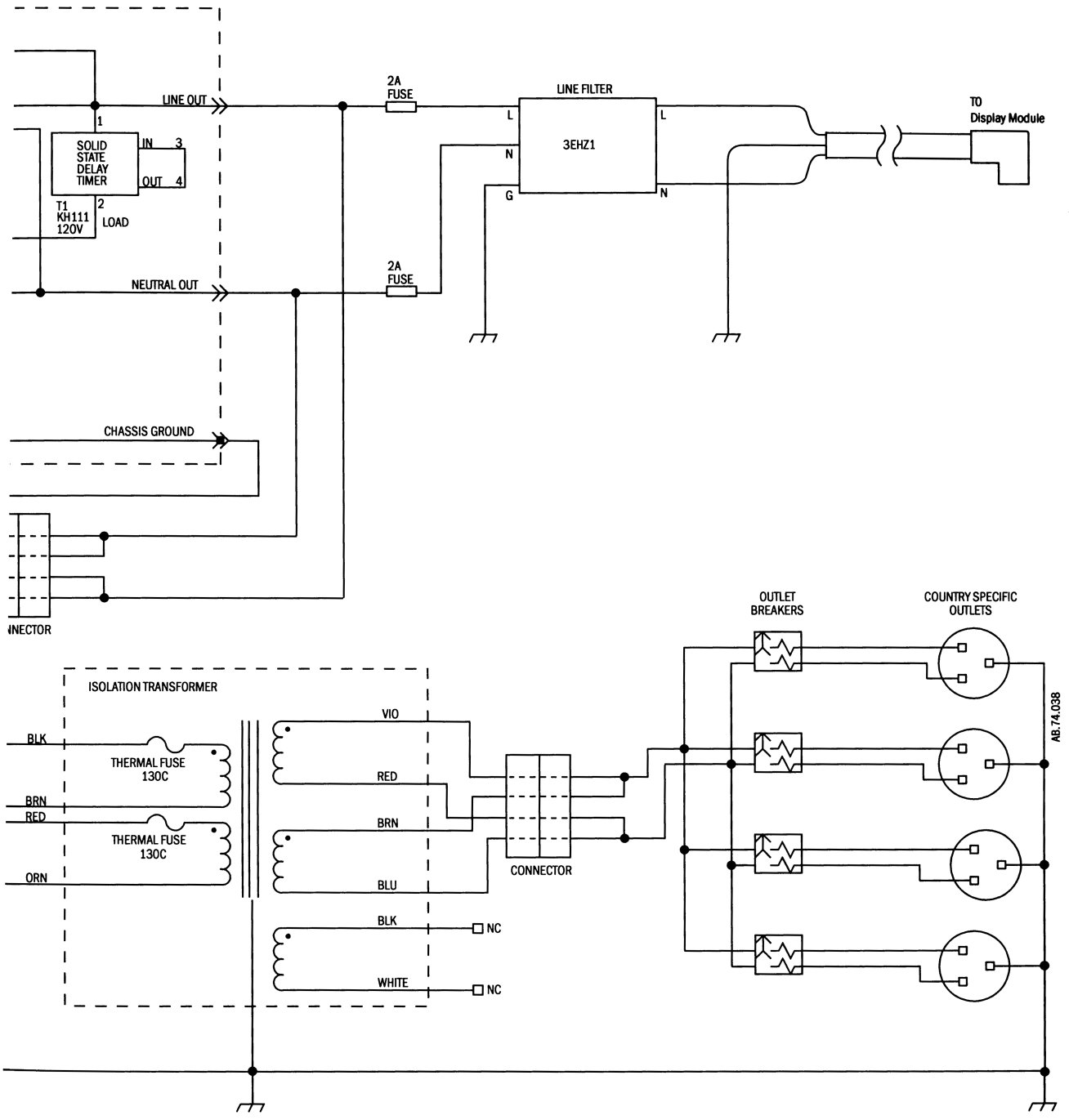


Figure 11-9 • Schematic, AC Inlet module; 100–120 V (Isolated outlets)

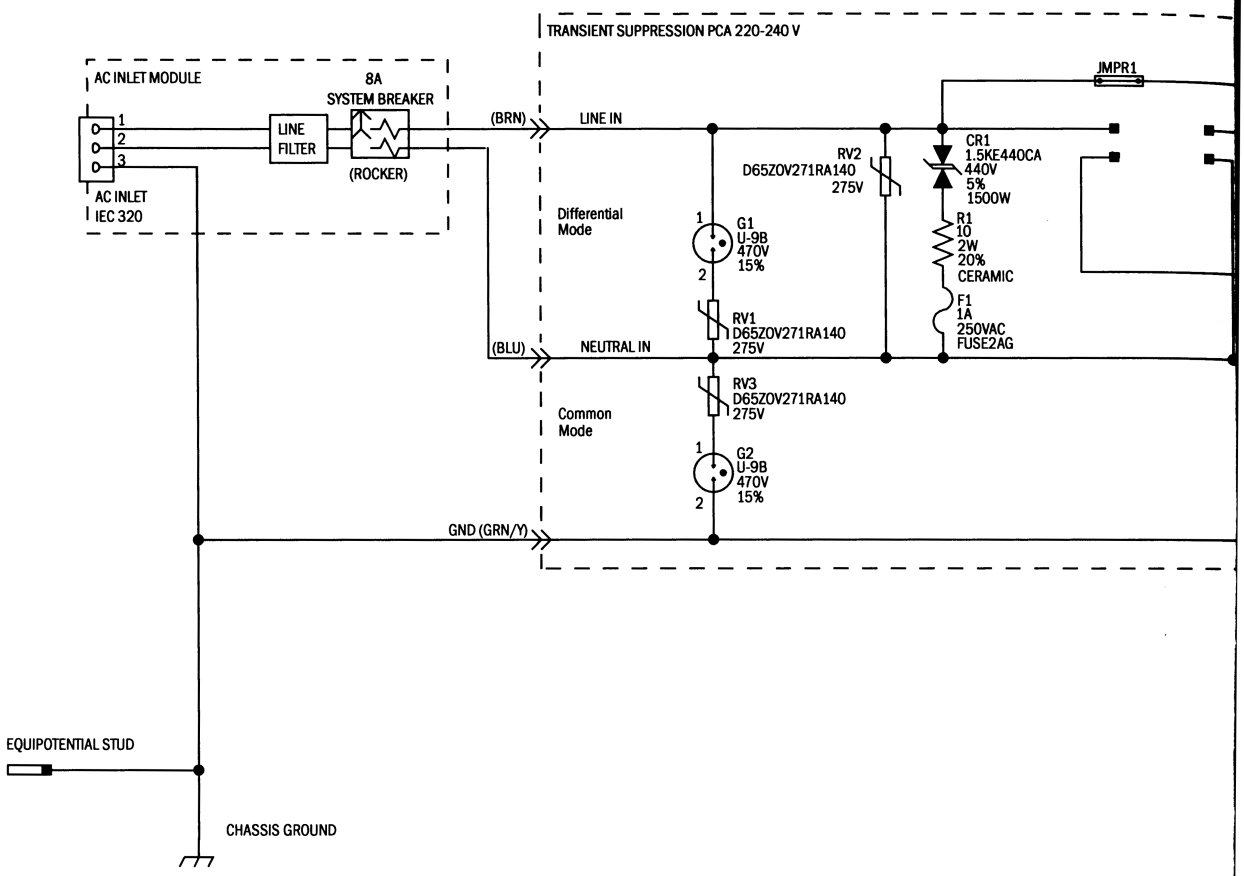
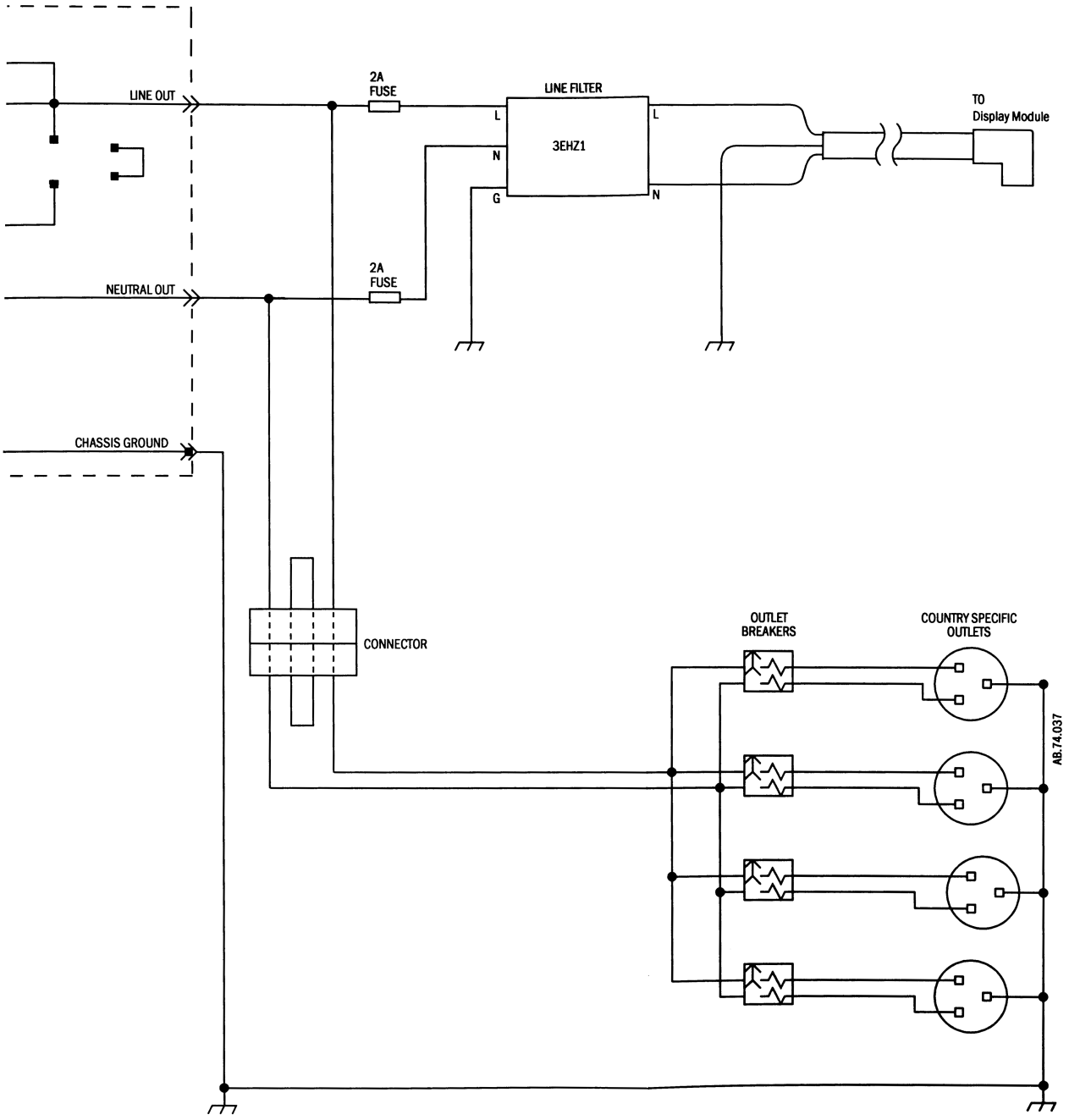
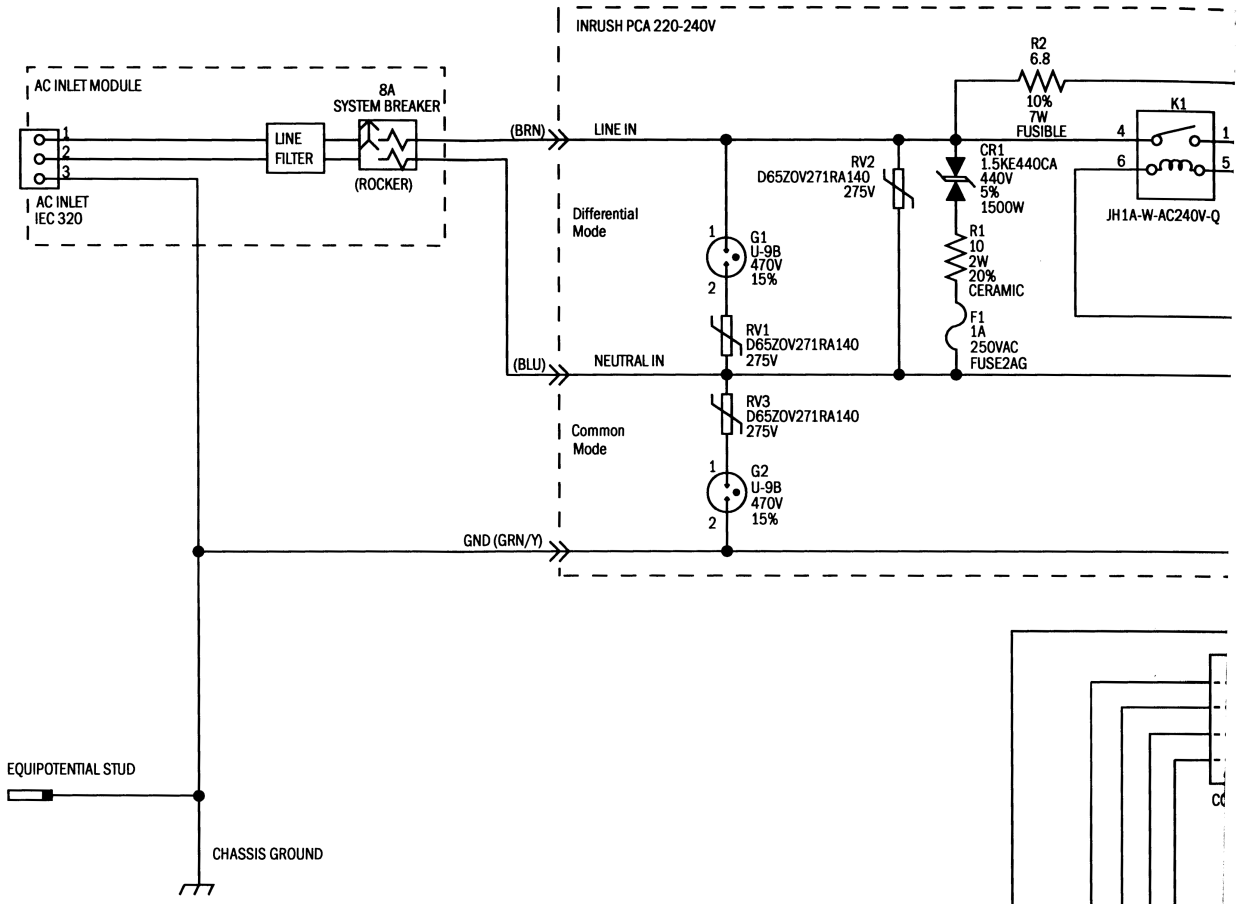


Figure 11-10 • Schematic, AC Inlet module; 220–240 V (Non-isolated outlets or no outlets)


LINE OUT
NEUTRAL OUT
CHASSIS GROUND
2A
FUSE
2A
FUSE
LINE FILTER
3EHZ1
L
N
G
L
N
TO
Display Module
CONNECTOR
OUTLET
BREAKERS
COUNTRY SPECIFIC
OUTLETS
AB.74.037


INRUSH PCA 220-240V
AC INLET MODULE
8A
SYSTEM BREAKER
LINE
FILTER
(ROCKER)
1
2
3
AC INLET
IEC 320
(BRN)
LINE IN
(BLU)
NEUTRAL IN
GND (GRN/Y)
Differential
Mode
Common
Mode
G1
U-9B
470V
15%
G2
U-9B
470V
15%
RV1
D65ZOV271RA140
275V
RV2
D65ZOV271RA140
275V
RV3
D65ZOV271RA140
275V
R2
6.8
10%
7W
FUSIBLE
CR1
1.5KE440CA
440V
5%
1500W
R1
10
2W
20%
CERAMIC
F1
1A
250VAC
FUSE2AG
K1
4
6
1
5
JH1A-W-AC240V-Q
EQUIPOTENTIAL STUD
CHASSIS GROUND

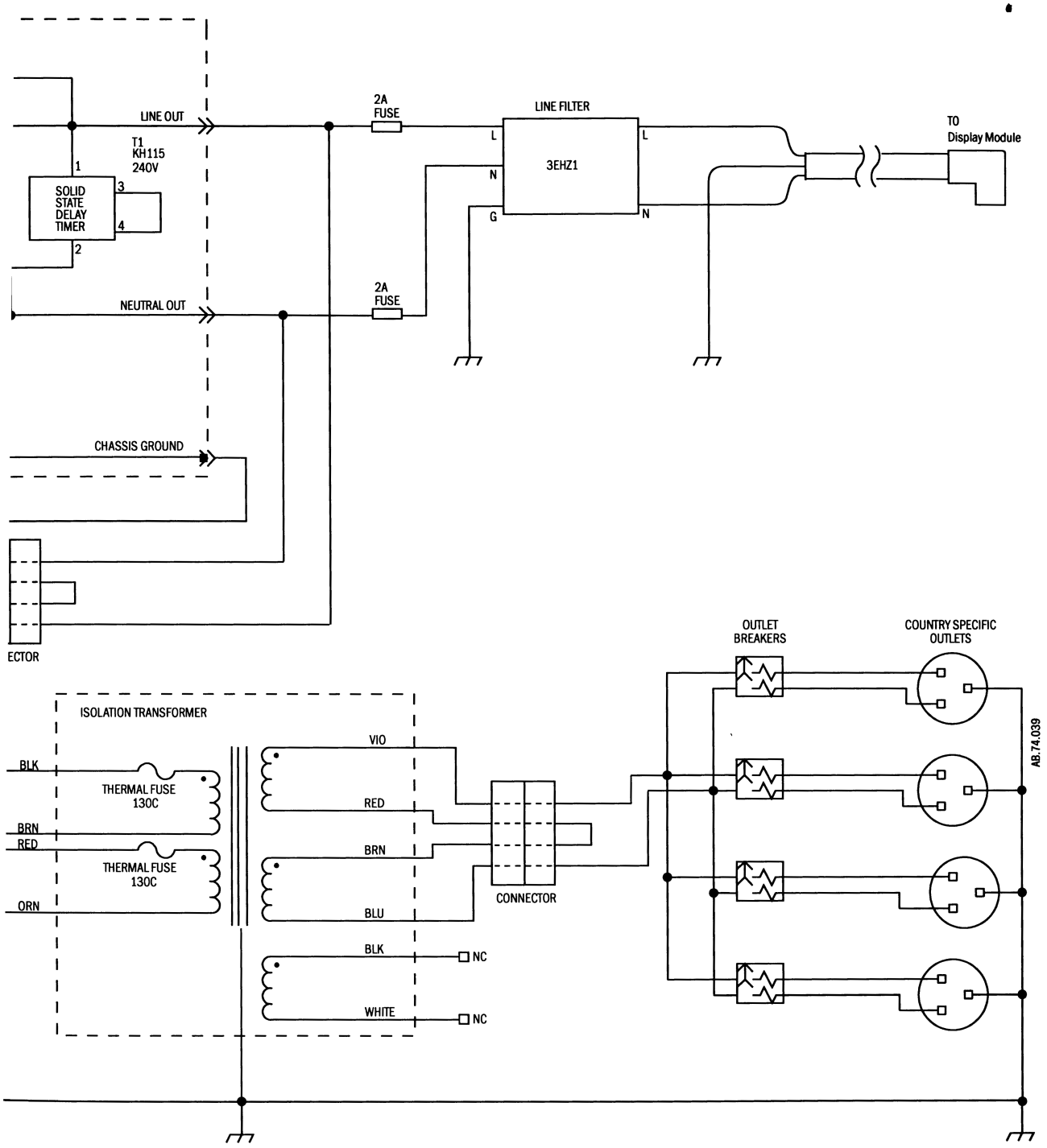


Figure 11-11 • Schematic, AC Inlet module; 220–240 V (Isolated outlets)

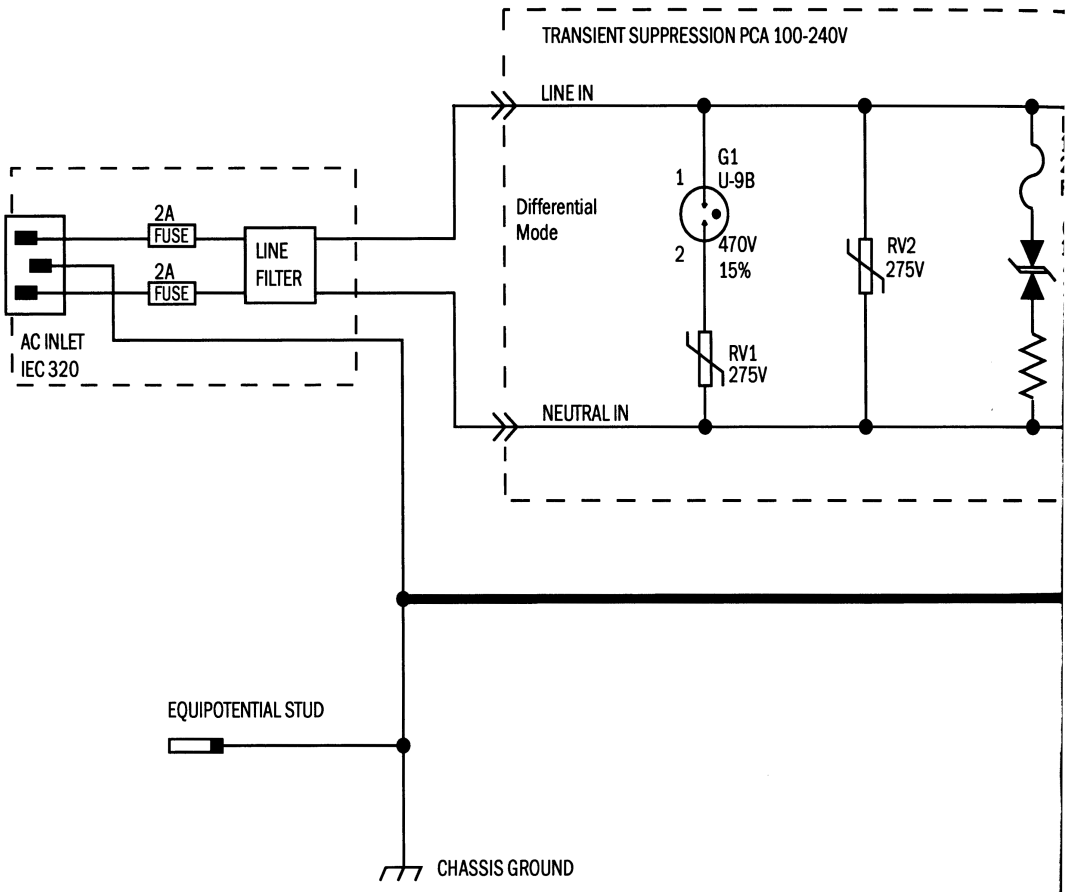
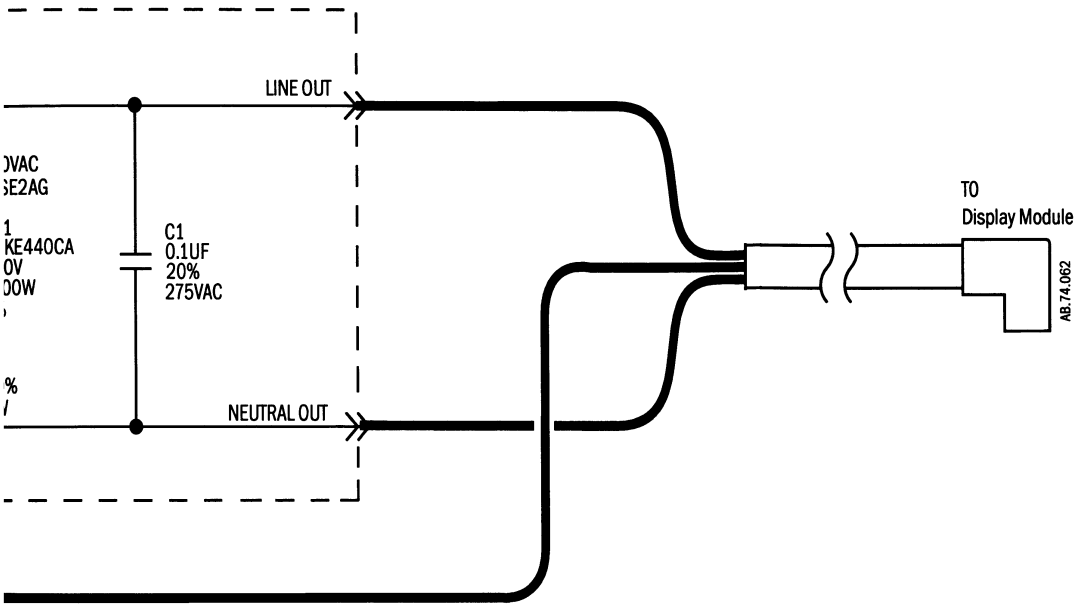


Figure 11-12 • Schematic, AC Power (Aespire 100)


LINE OUT
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Corporate Office

EC REP

GE Healthcare Finland Oy
Kuortaneenkatu 2
Helsinki, Finland
FI-00510
Tel 358 10 394 11
Fax 358 9 146 3310

North America

United States

Customer Service, Technical Support and Distribution Center
Datex-Ohmeda, Inc.
3030 Ohmeda Drive
Madison, WI 53718-6794
USA
Tel 1 800 345 2700
Fax 1 608 221 4384

Equipment Service Center
GE Healthcare
1701 Military Trail,
Suite 150
Jupiter FL 33458-7887
USA
Tel 1 561 575 5000
Fax 1 561 575 5070

Canada

GE Healthcare
2300 Meadowvale Blvd
Mississauga, Ontario
L5N 5P9
Canada
Tel 1 800 668 0732
Fax 1 905 858 5292

Asia/Pacific

China

GE (China) Co. Ltd - Healthcare
2401 MAXDO Center
No. 8 Ying Yi Road
Hongqiao
Development Zone
200336 Shanghai
China
Tel 86-21-52574650
Fax 86-21-52082012

GE Medical Systems (China) Co., Ltd.
No. 19 Changjiang Road,
Wuxi
National Hi-Tech
Development Zone,
Jiangsu, PR China 214028
Tel 0510-85225888
Fax 0510-85226688

Hong Kong

GE Healthcare
Hong Kong Ltd.
11/F, The Lee Gardens,
33 Hysan Avenue
Causeway Bay
Hong Kong
Tel +852 2100 6300
Fax +852 2100 6292

India

WIPRO GE Medical
Systems Pvt. Ltd.
4 Kadugodi Industial Area
Sadaramangala
Bangalore
Karnataka 560067
India
Tel +914 1801 0000
Fax +91 28 452 926

Indonesia

PT GE Technology
Indonesia
BRI Building Tower II
26th Floor
Jln. Jend Sudirman Kav.
44-46 Jakarta 10210,
Indonesia
Tel +6221 573 0545
Fax +6221 574 7117

Japan

GE Yokogawa
Medical Systems
4-7-127 Asahigaoka,
Hino-shi,
Tokyo 191-8503
Japan
Tel 81 42 585 5111
Fax 81 42 585 5360

Korea

GE Medical Systems Korea
Seowoo B/D 837-12
Yeoksamdong
Kangnamgu
Seoul, OS 135-080
Korea
Tel +82 2301 66001
Fax +82 2567 7357

Malaysia

General Electric
International Inc.
Suite 3B-8-3, Block 3B
Level 8, Plaza Sentral
Jalan Stesen Sentral 5
Kuala Lumpur Sentral
50470 Kuala Lumpur
Malaysia
Tel +603 2273 9788
Fax +603 2273 3486

Philippines

GE Philippines, Inc.
2291 Don Chino Roces
Avenue Ext.
Makati City 1231
Philippines
Tel +632 815 8761
Fax +632 816 4997

Singapore

GE Pacific Pte. Ltd.
298 Tiong Bahru Road
#15-01/06 Central Plaza
Singapore 168730
Tel +65 291 8528
Fax +65 277 7688

Taiwan

GE Healthcare Taiwan
11F, 420 Fu Hsin N Road
Taipei, 104
Taiwan
Tel +886 22 2516 5280
Fax +886 22 2516 5290

Thailand

GE Medical Systems
(Thailand) Ltd.
7th Floor
Thanapoom Tower
1550 New Petchburi Road
Makasan, Ratthewi
Bangkok 10400
Thailand
Tel +662 624 8444
Fax +662 624 8431

Vietnam

GE Viet Nam Limited
Metropole Centre
Suite 606-2
56 Ly Thai To Street
Hanoi
Vietnam
Tel +844 934 4254
Fax +844 825 0551

GE Viet Nam Limited
Sun Wah Tower
Suite 1202
115 Nguyen Hue Street
Ho Chi Minh City
Vietnam
Tel +848 812 9399
Fax +848 821 9482

Australia/ New Zealand

GE Healthcare
Australia Pty. Ltd.
Parklands Estate,
Building 4B
21 South Street
Rydalmere NSW 2116
Australia
Tel +61 2 9846 4000
Fax +61 2 9846 4001

Europe

CIS/Baltics

Datex-Ohmeda
Regional Head Office
PO Box 70071
GR-16610 Glyfada -
Athens
Greece
Tel +30 10 9625136-7
Fax +30 10 9623687v

France

GE Healthcare
Information Technologies
& Perinatal Care
11, avenue Morane
Saulnier
78457 Velizy Cedex
France
Tel +33 1 34 49 53 00
Fax +33 1 34 49 53 01

GE Healthcare
Zac de Sans-Souci
1211 Chemin de la Bruyère
69578 Limonest Cedex
France
Tel +33 (0)4 78 66 62 10
Fax +33 (0)4 78 43 26 58

Germany

Datex-Ohmeda GmbH
Munzinger Strasse 3
79111 Freiburg
Germany
Tel +49 761 4543 0
Fax +49 761 4543 233

GE Service Center
T: 0800 434325842273
T: 0800 GEHealthcare

Italy

GE Healthcare
Clinical Systems srl
Via Galeno 36
20126 Milan
Italy
Tel +39 02 26001111
Fax +39 02 26001599

Netherlands

GE Healthcare
De Wel 18
Postbus 22
3870 CA Hoevelaken
Netherlands
Tel 31 33 2541 222
Fax 31 33 2541 223

Spain

GE Healthcare
Avenida de Europa, 22
P.E. La Moraleja
28018 Alcobendas
Madrid
Spain
Tel +34 91 663 2500
Fax +34 91 663 25 01

Sweden

GE Healthcare IT AB
Box 110 70
161 11 Bromma
Sweden
Tel +46 20-389550
Fax +46 8-293530

United Kingdom

Datex-Ohmeda Ltd.
Ohmeda House
71 Great North Road
Hatfield Hertfordshire
AL9 5EN
England
Tel 44 1707 263570
Fax 44 1707 260191

Latin America, Caribbean

GE Healthcare
3350 SW 148th Avenue
Suite 301
Miramar FL 33027-3259
USA
Tel 954 744 5600
Fax 954 744 5613

GE Healthcare
Rua Tomas Carvalhal
711 - Bairro Paraiso
San Paulo, SP 04006-002
Brazil
Tel 55 11 3053 2500/2537

Middle East/ Africa

Datex-Ohmeda
Regional Head Office
PO Box 70071
GR-16610 Glyfada -
Athens
Greece
Tel +30 10 9625136-7
Fax +30 10 9623687

Datex-Ohmeda, Inc., a General Electric Company,
doing business as GE Healthcare.
P.O. Box 7550
Madison, WI 53707-7550
USA

www.gehealthcare.com

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